QUARTERLY REPORT NO. 9

(SEPTEMBER 1,1976 TO NOVEMBER 30,1976)

ENVIRONMENTAL BASELINE DATA COLLECTION

AND

MONITORING PROGRAM

FEDERAL PROTOTYPE OIL SHALE

LEASING PROGRAM

TRACTS U-a and U-b

UTAH

WHITE RIVER SHALE PROJECT

vtn

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I. INTRODUCTION

This document is a summary of work conducted from September 1 to November 30, 1976, as part of the environmental baseline monitoring program for Tracts U-a and U-b. The baseline program is being conducted in accordance with the Partial Exploration Plan, Environmental Baseline Data Collection and Monitoring Element, submitted July 1, 1974, and the Conditions of Approval developed by the Area Oil Shale Supervisor (AOSS) for various sub-elements of the program. As requested by the AOSS, the field data collected for this quarter have also been submitted and are on file in the AOSS office in Grand Junction, Colorado.

This report is the final quarterly baseline report. It interprets and analyzes data that will be incorporated within the Final Environmental Baseline Report (FEBR), which covers the period from the beginning of each baseline monitoring program element to January 15, 1977, or a period of not less than two years. Data compiled after this quarterly reporting period will be made available to the AOSS office as supplementary data to the FEBR.

Data collection and reporting after January 15, 1977, for the suspension monitoring period are covered within the Work Plan--Lease Suspension Period Environmental Programs, WRSP. This plan was submitted to the AOSS on December 17, 1976, and has subsequently been approved for implementation.

II. WATER RESOURCES

A. WORK COMPLETED

Field-data collection for the two-year environmental baseline water resources program was concluded September 30, 1976, the end of Water Year 1976. An interim monitoring program that began October 1, 1976, will extend to January 15, 1977, the end of baseline monitoring for all programs.

Data for this quarterly report is limited because of the one-month reporting period and because the USGS has not finalized the data for the 1976 water year.

Static water levels were measured in all wells in September. Continuous water level monitoring was conducted at the P-1, P-2 upper, P-2 lower, and P-3 sites. Pumped samples were collected from the bedrock aquifer wells, as required by the January 26, 1976 Conditions of Approval, and were submitted for analysis to the USGS in Denver.

B. DATA SUMMARY

1. SURFACE WATER

As previously noted, the data are limited, and therefore the following report is a limited comparison of 1976 records with those of the previous year.

a. Streamflow

White River

The preliminary measurements of streamflow in the White River below Asphalt Wash in 1976 (Station S-11) are shown on Figure II-1. Although data from the other three stations on the White River are not yet in a form suitable for direct comparisons, the data now available indicate that flow at these stations is very similar to the flow at Station S-11. The final results for all of the stations will be available for the Final Environmental Baseline Report (FEBR).

STREAMFLOW
WHITE RIVER BELOW ASPHALT WASH, UTAH - (S-11)
OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-1

Streamflow during 1976 was similar to that of 1975 during baseflow and lower-basin snowmelt, but upper-basin snowmelt this year was earlier and produced less runoff. Because of less snowmelt, the average flow this year was only 15.8 m^3/s (550 cfs), which is well below the average of 20 m^3/s (700 cfs).

Evacuation Creek

Figure II-2 shows the preliminary streamflow measurements near the mouth of Evacuation Creek during the 1976 water year. Flows recorded through the year have been similar to those of last year, but peak flows from snowmelt occurred approximately 20 days earlier. Detailed analysis will not be possible until the data are reduced.

Hells Hole Canyon, Southam Canyon, and Asphalt Wash

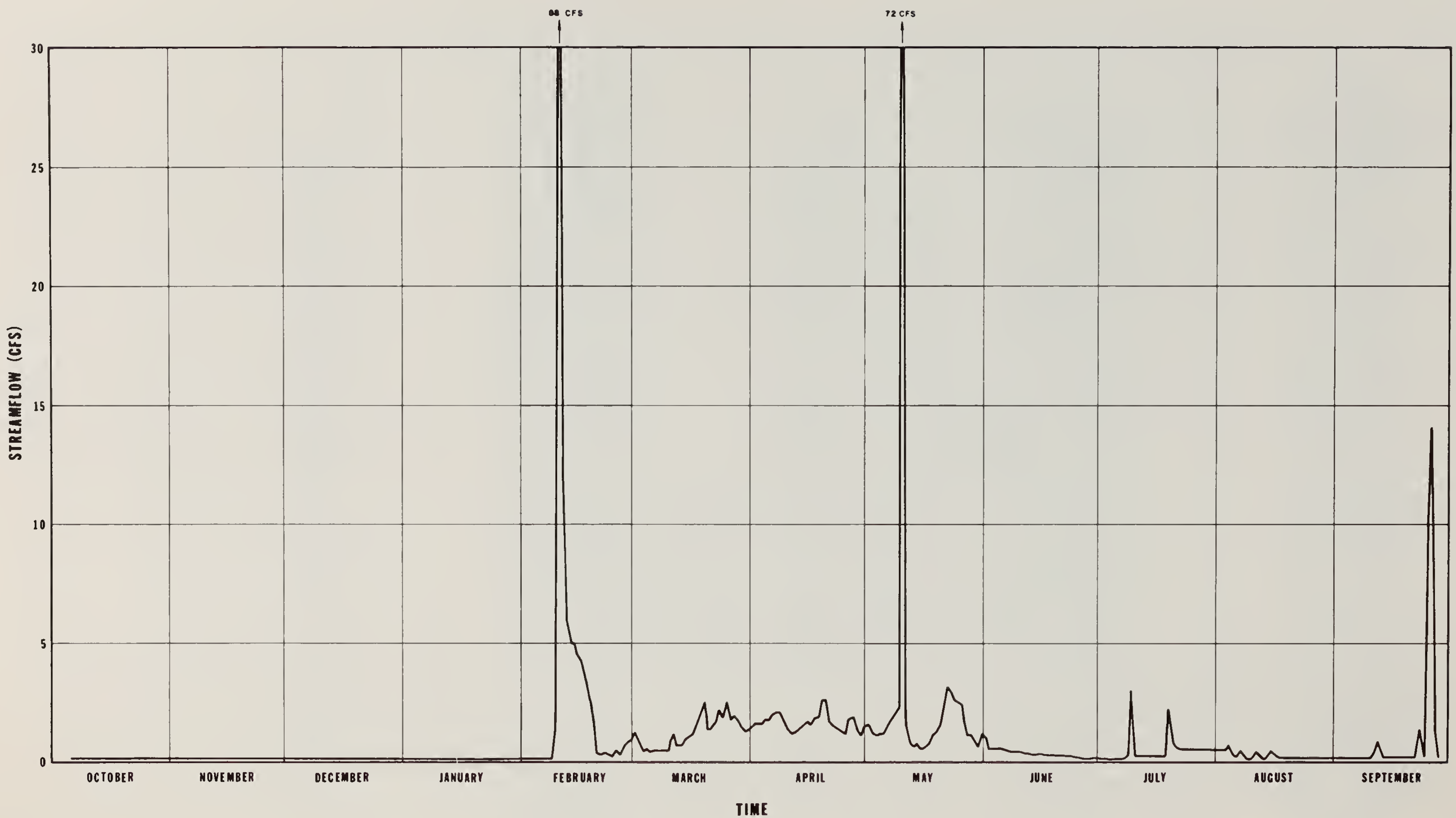
These canyons had flowing water for short periods between March and October. Because the records are preliminary, no conclusions about the flows can be made at this time.

b. Precipitation and Evaporation

The precipitation and evaporation records from October 1975 through September 1976 are shown on Table II-1. The precipitation values are about the same as during the same period the preceding year, although spatial and temporal distribution is different. Evaporation for the May-September period this year was only 85% of last year's figures.

2. SURFACE WATER QUALITY

The data have not been analyzed, and therefore the following discussion is based on a data comparison with previous trends and concentrations of the same period last year.



STREAMFLOW

EVACUATION CREEK NEAR MOUTH BELOW WATSON, UTAH - (S-2)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-2

TABLE II-1

1975-1976 PRECIPITATION RECORDS (cm)

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT-APR	MAY-SEP	ANNUAL
Evaporation 1	11.05	2.69						10.60	17.58	21.21	21.68	12.23			
Evaporation 2	12.88	2.80						11.06	17.92	20.86	22.54	11.82			
RS-PS	4.01	0.84	0.99	0.74	0.74	3.20	2.39	4.37	2.18	0.91	0.86	2.16	12.90	10.49	23.37
RS-13	3.73	0.94	3.91	0.56	0.99	3.00	1.91	3.66	3.05	1.19	1.68	2.49	15.04	12.07	24.87
RS-12	3.53	0.89	4.47	0.71	0.46	3.18	1.85	2.95	1.42	1.17	1.09	3.07	15.09	9.70	22.17
ARS-12					0.51	3.30	1.78	3.56	2.29	1.52	0.51	3.05		10.92	16.76
RS-11					0.99	3.15	1.60	2.92	1.42	1.27					
RS-9	5.33	1.04	4.37	0.84	1.14	3.23	2.64	3.43	2.06	1.02	1.30	2.72	18.59	10.52	25.93
ARS-9					0.76	3.05	2.54	3.30	2.54	1.02	1.27	2.54		10.67	17.02
RA-8					0.91	2.29	2.59	3.20	1.85	1.55					
ARA-8					1.02	2.03	2.29	2.79	2.29	2.03	1.78	3.30		12.19	17.53
RS-6	3.53	0.84	1.83	0.66	2.08	2.62	3.23	2.84	1.63	1.09	1.35	3.86	14.78	10.77	25.55
RS-4					0.84	3.20	2.01	4.22	2.74	0.46					
ARS-4					0.76	2.54	2.03	4.57	2.79	0.51	0.76	2.29		10.92	16.51
RS-3	3.38	0.89	1.42	0.51											
RA-2					0.89	2.72	1.68	2.97	2.44	0.91					
ARA-2	4.06	0.76			1.02	3.05	1.27	3.81	3.30	1.27	1.27	2.29		11.94	24.38
RS-1	3.48	0.81	1.68	0.46	0.43	1.04	2.77	3.02	1.98	1.55	1.30	1.55	10.67	9.40	19.84
RP-1					0.91	2.18	2.34	1.83	1.52	0.91					
ARP-1	3.81	1.02	0.76	0.51	1.02	2.54	2.29	2.79	2.29	1.27	1.02	1.52	11.94	8.89	20.83

a. Streams

White River

Water Quality in the White River this year showed the same trends and concentrations as in the first year. This can be seen by comparing figures II-3 through II-8 with the equivalent figures and discussion in the FYEBR (figures II-20 through II-31).

Evacuation Creek

The trends and concentrations in the quality of Evacuation Creek this year was also similar to those of last year, as shown in a comparison of figures II-9 through II-14 with the equivalent figures and discussion in the FYEBR.

Southam Canyon, and Asphalt Wash

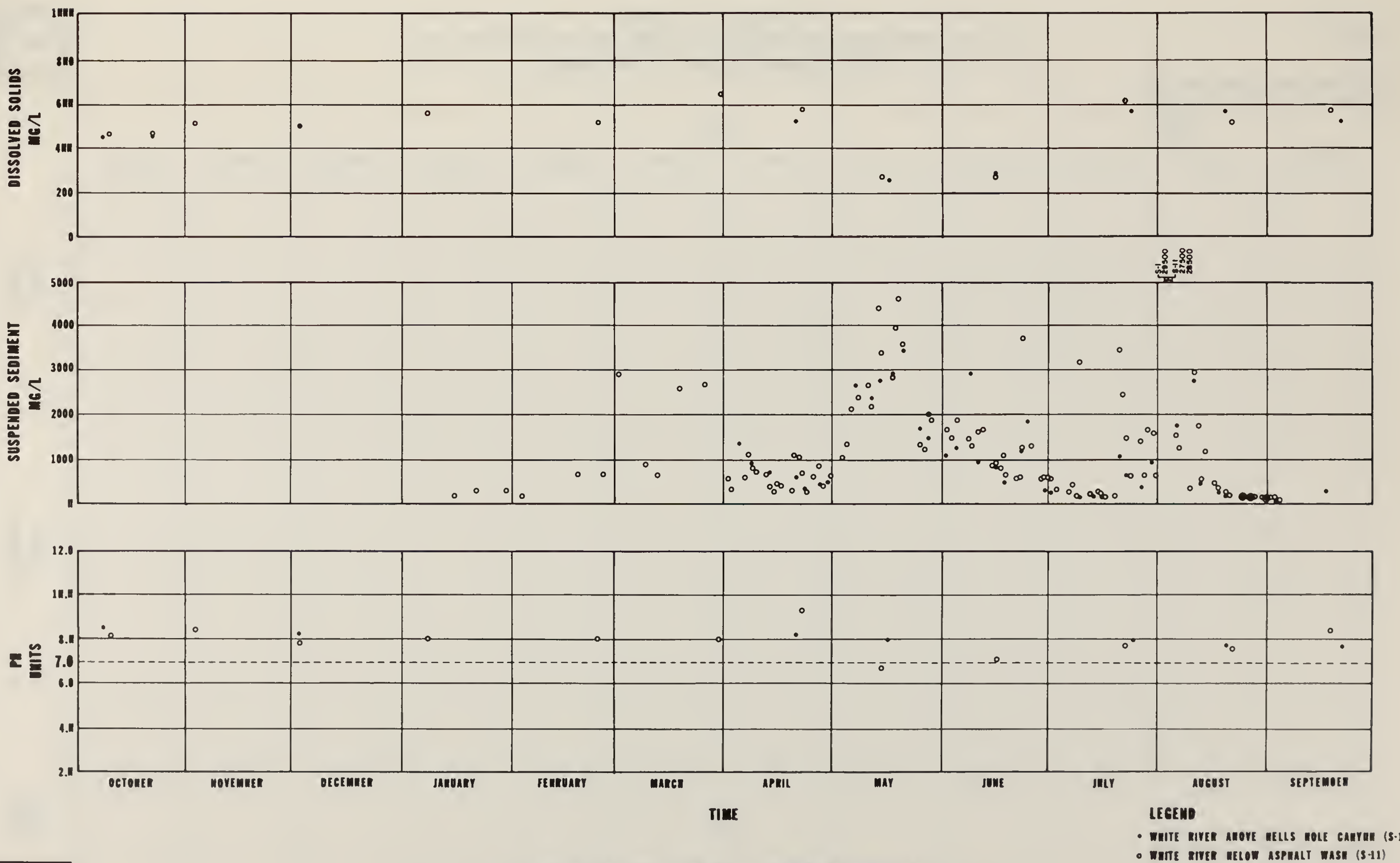
So far this year, four samples have been collected from Southam Canyon and Asphalt Wash. The first six were from snowmelt runoff, and therefore they were fairly low in dissolved solids. The last two samples were of runoff from rainfall in June and were a sodium sulfate type of water.

3. GROUND WATER LEVEL MONITORING

Hydrographs constructed from monthly static water level records were reported in Quarterly Report No. 8, pages II-21 through II-28. Hydrographs constructed from the continuous recording wells are shown on figures II-15 through II-18.

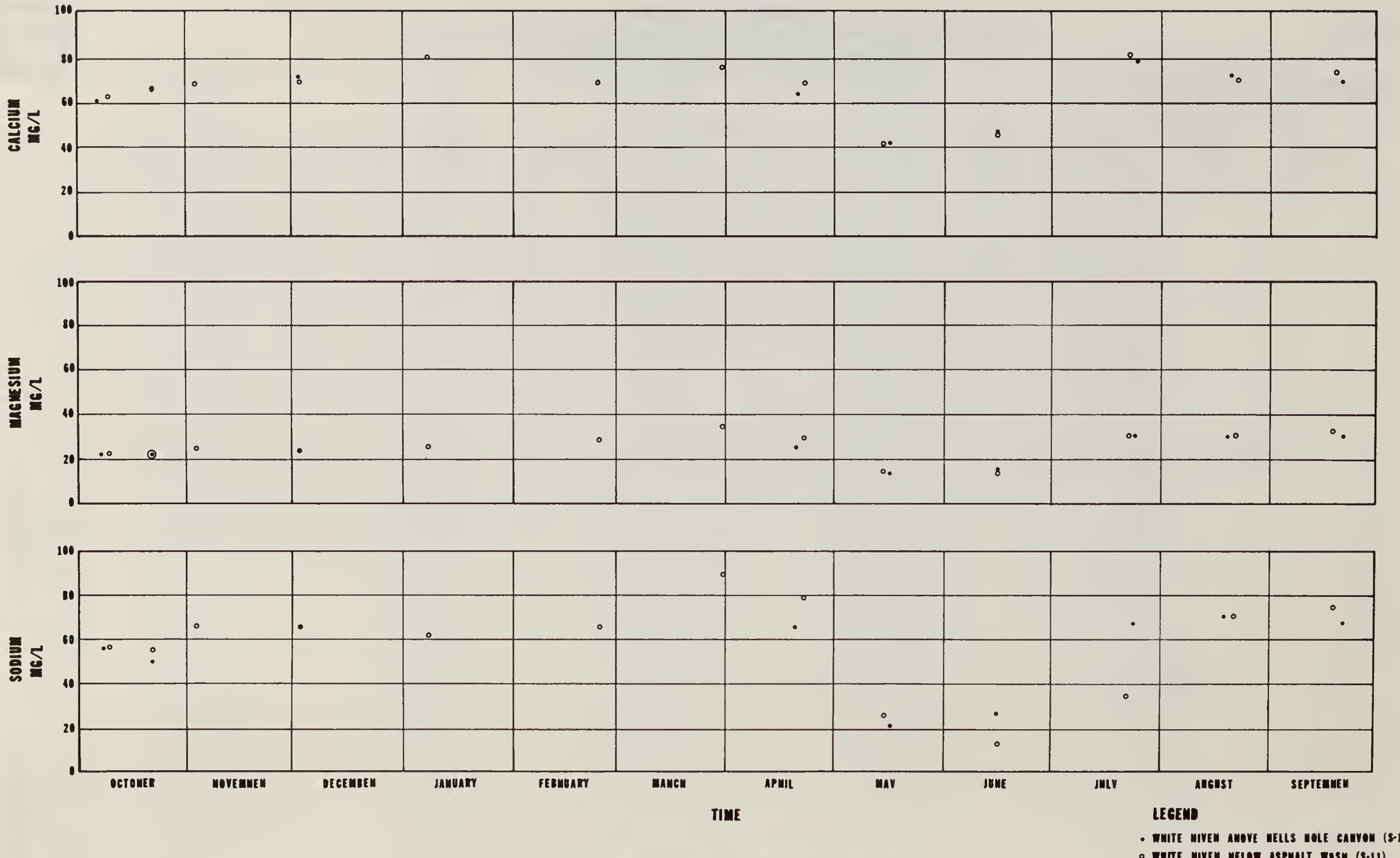
4. GROUND WATER QUALITY

The computer listing for all of the bedrock ground water quality analyses of samples collected in the 1976 water year, except those collected in September, are included in the field data report. The individual lab sheets for alluvial well water quality analyses are also included in the field data report.



VARIATION OF GENERAL CHARACTERISTICS
WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)
OCTOBER 1975 - SEPTEMBER 1976

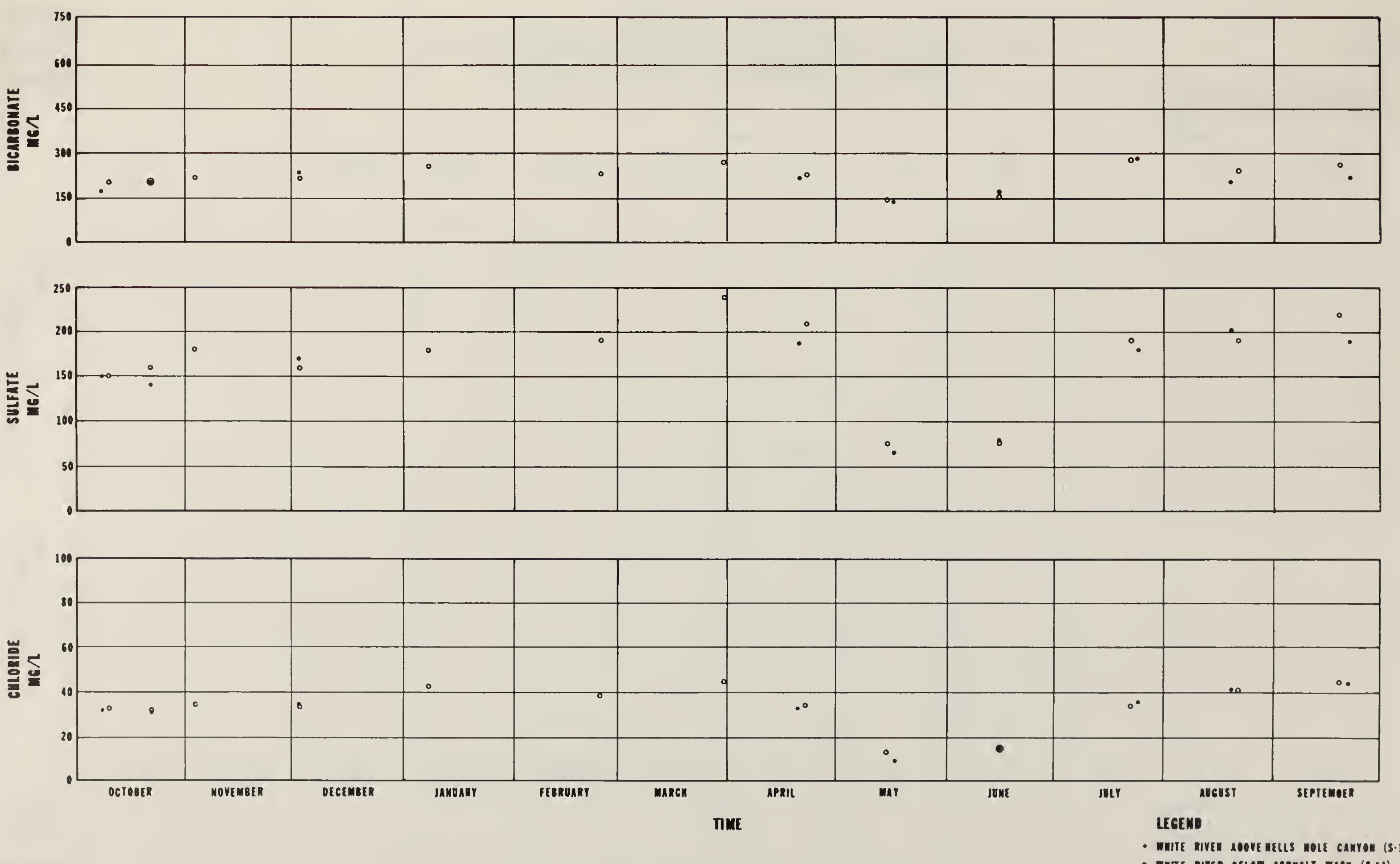
FIGURE II-3



VARIATION IN TIME OF MAJOR CATIONS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)
OCTOBER 1975 - SEPTEMBER 1976

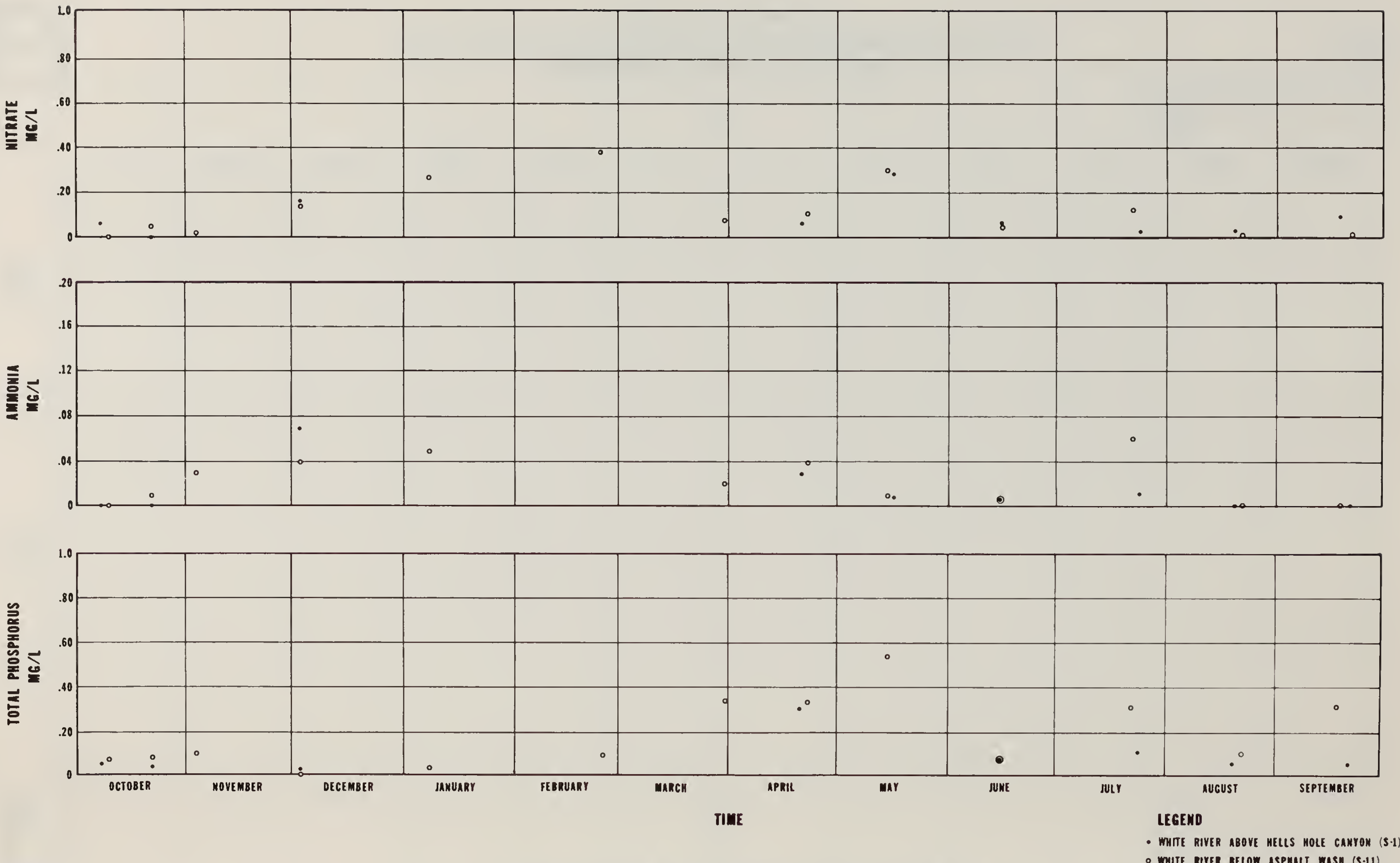
FIGURE II-4



VARIATION IN TIME OF MAJOR ANIONS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)
OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-5

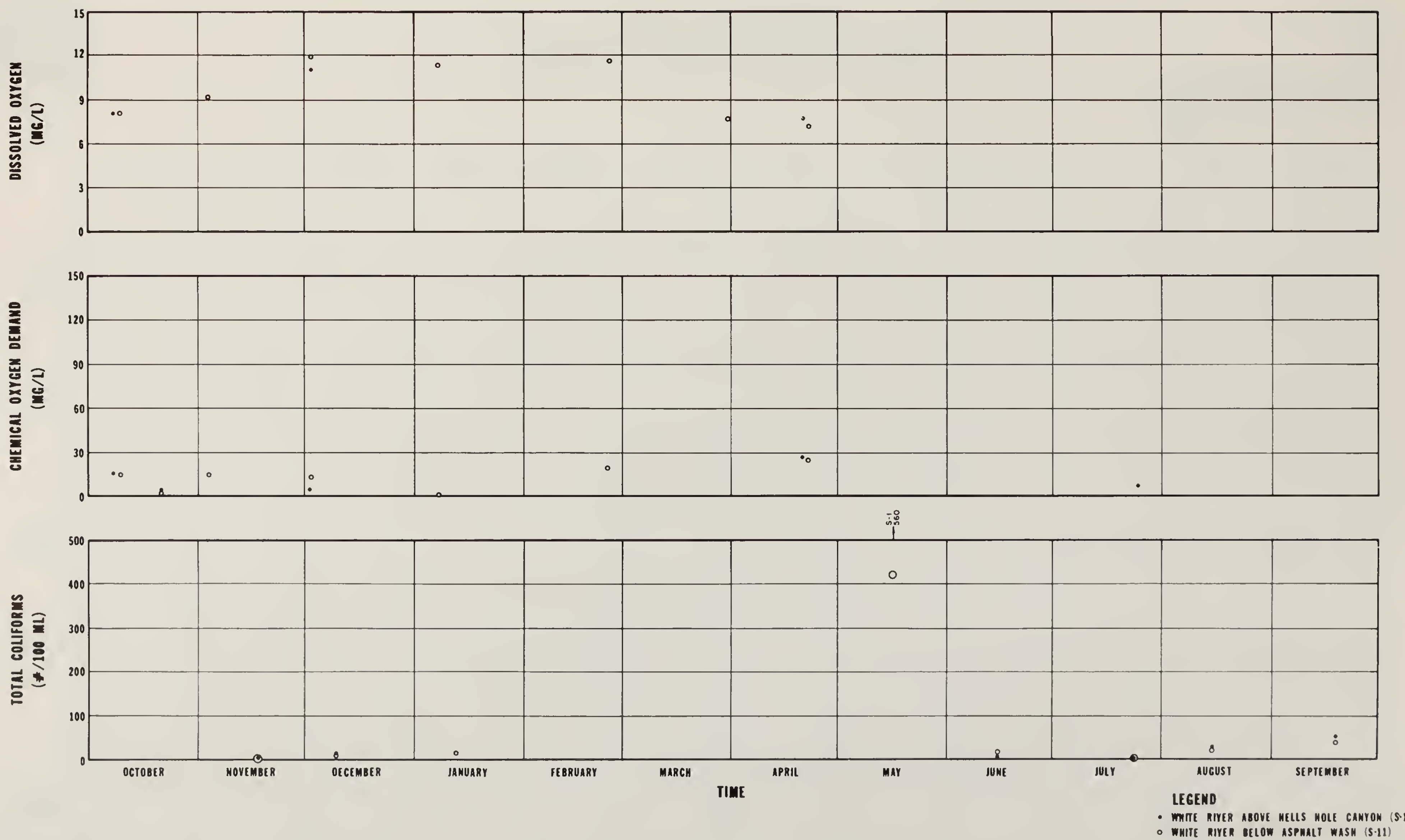


VARIATION IN TIME OF REPRESENTATIVE NUTRIENTS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-6

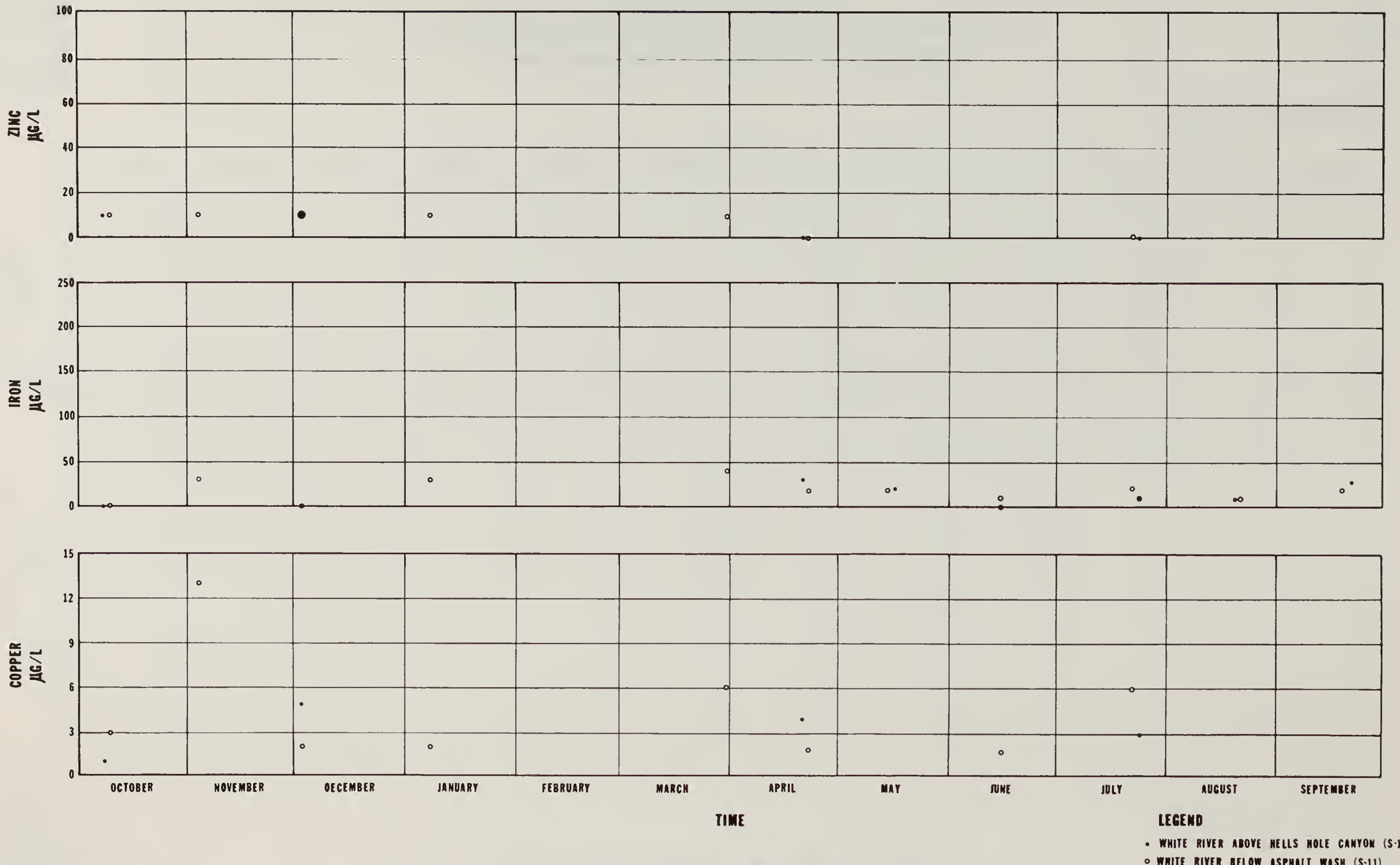


VARIATION IN TIME OF BIOCHEMICAL CONSTITUENTS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-7

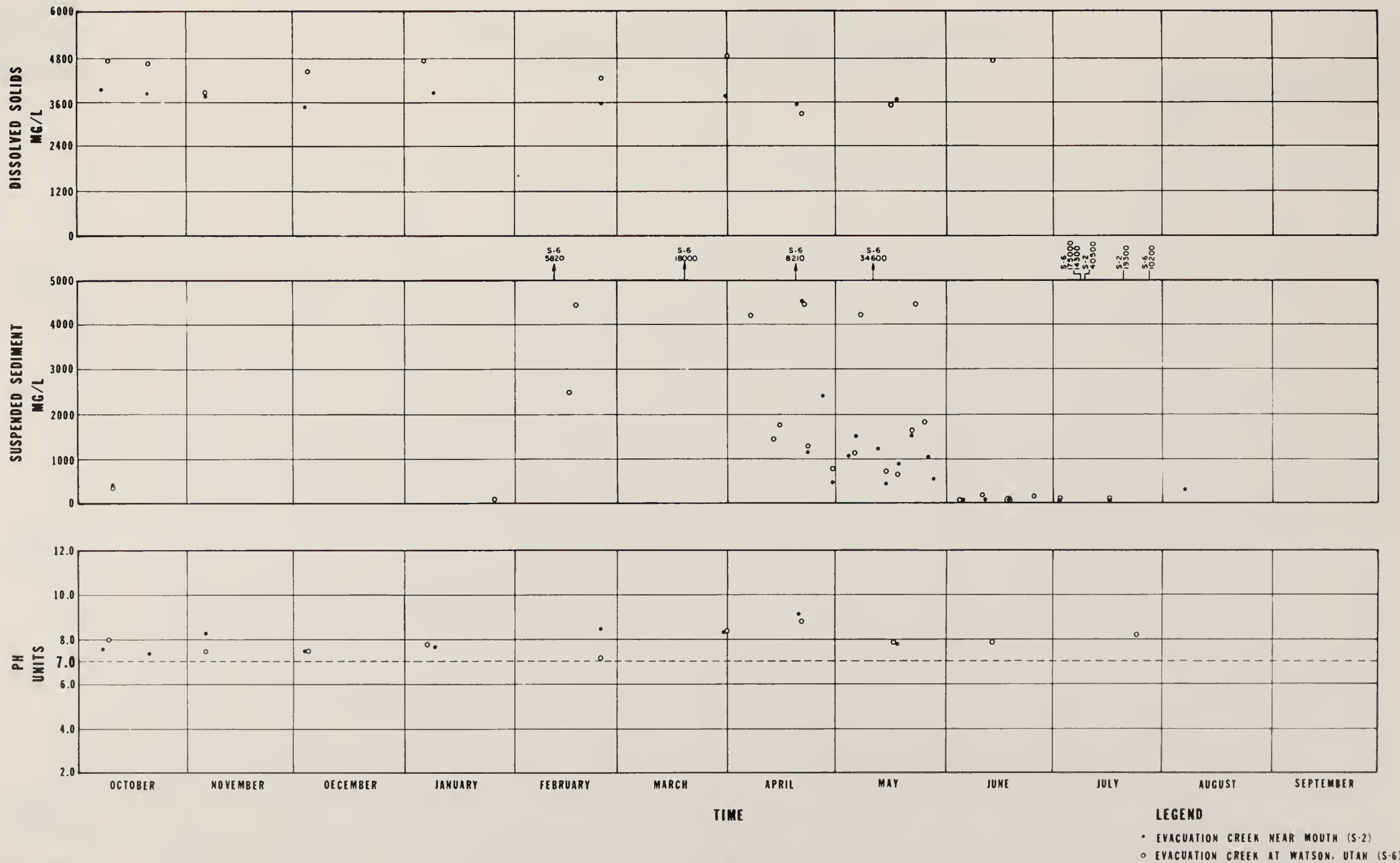


VARIATION IN TIME OF SOME TRACE ELEMENTS

WHITE RIVER ABOVE HELLS HOLE CANYON (S-1) AND WHITE RIVER BELOW ASPHALT WASH (S-11)

OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-8

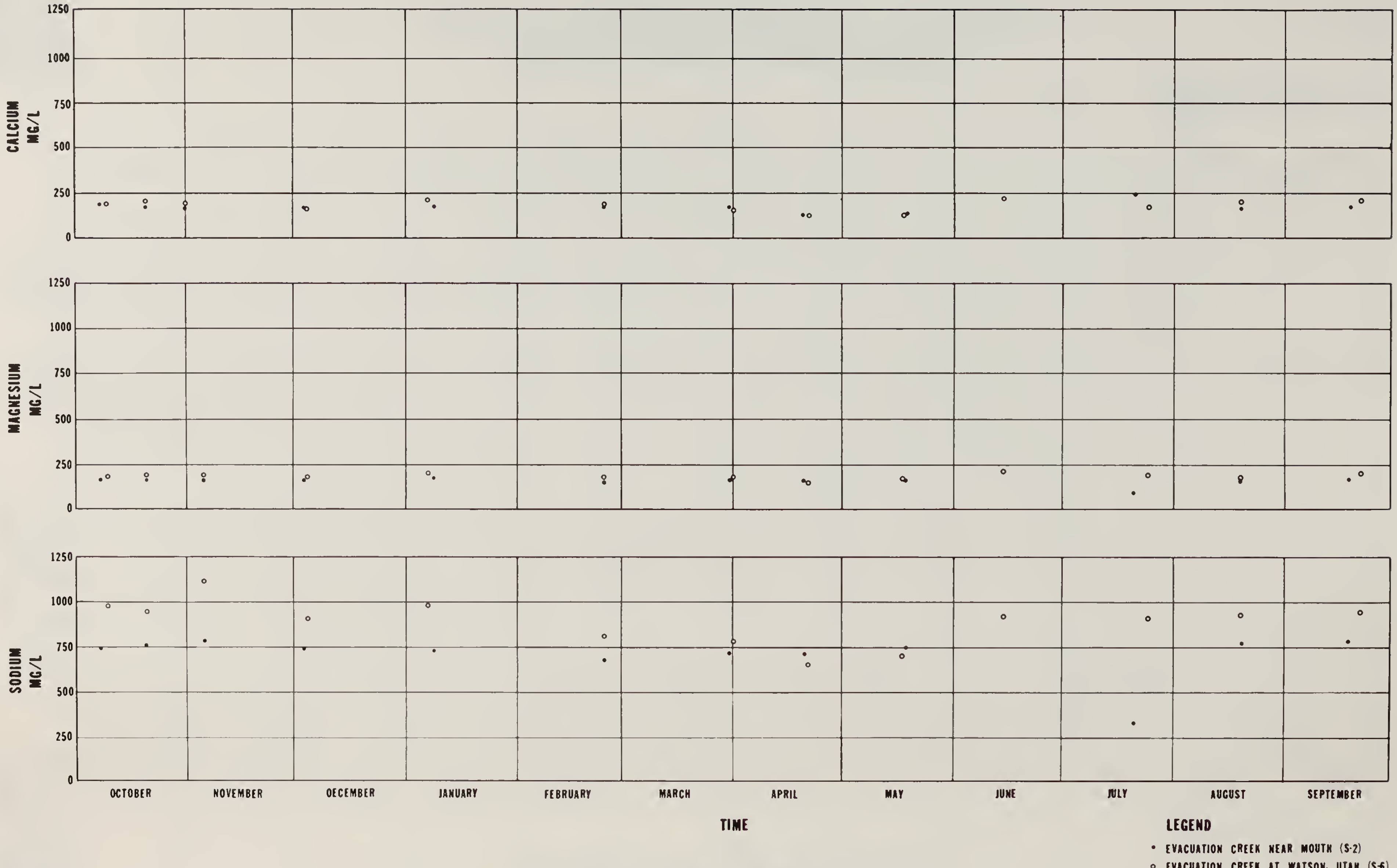


VARIATION OF GENERAL CHARACTERISTICS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

OCTOBER 1975 - SEPTEMBER 1976

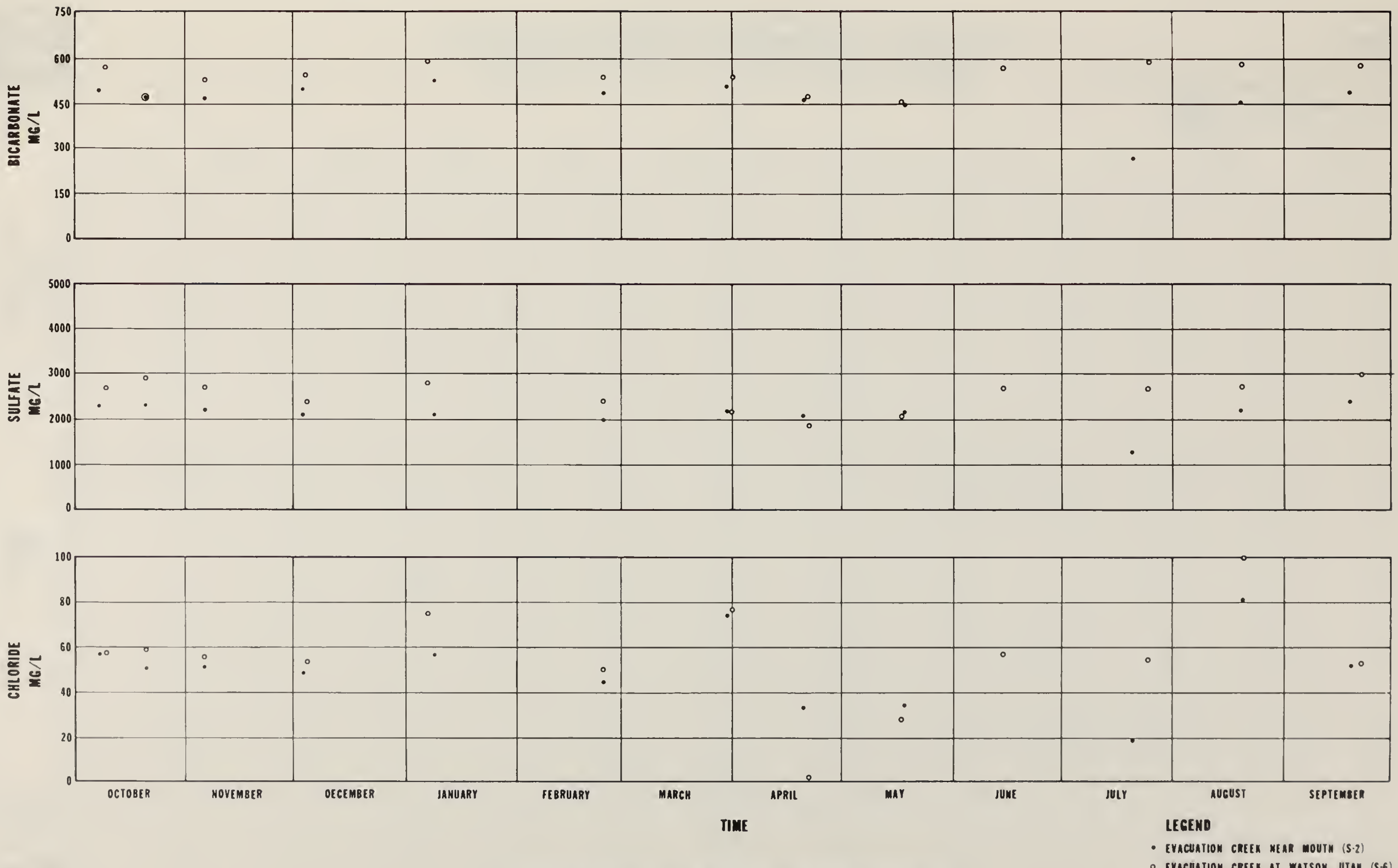
FIGURE II-9



VARIATION IN TIME OF MAJOR CATIONS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)
OCTOBER 1975 - SEPTEMBER 1976

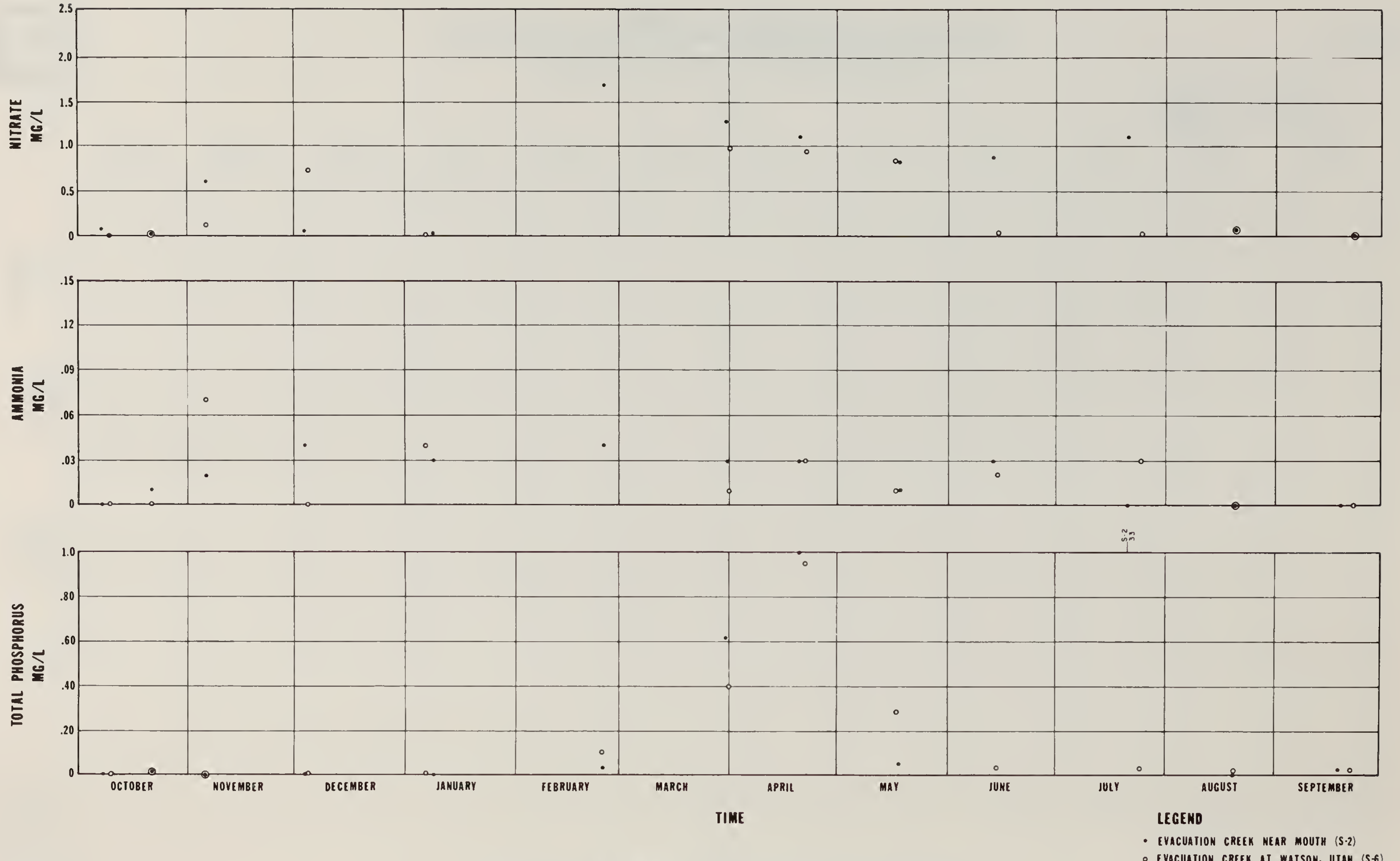
FIGURE II-10



VARIATION IN TIME OF MAJOR ANIONS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)
OCTOBER 1975 - SEPTEMBER 1976

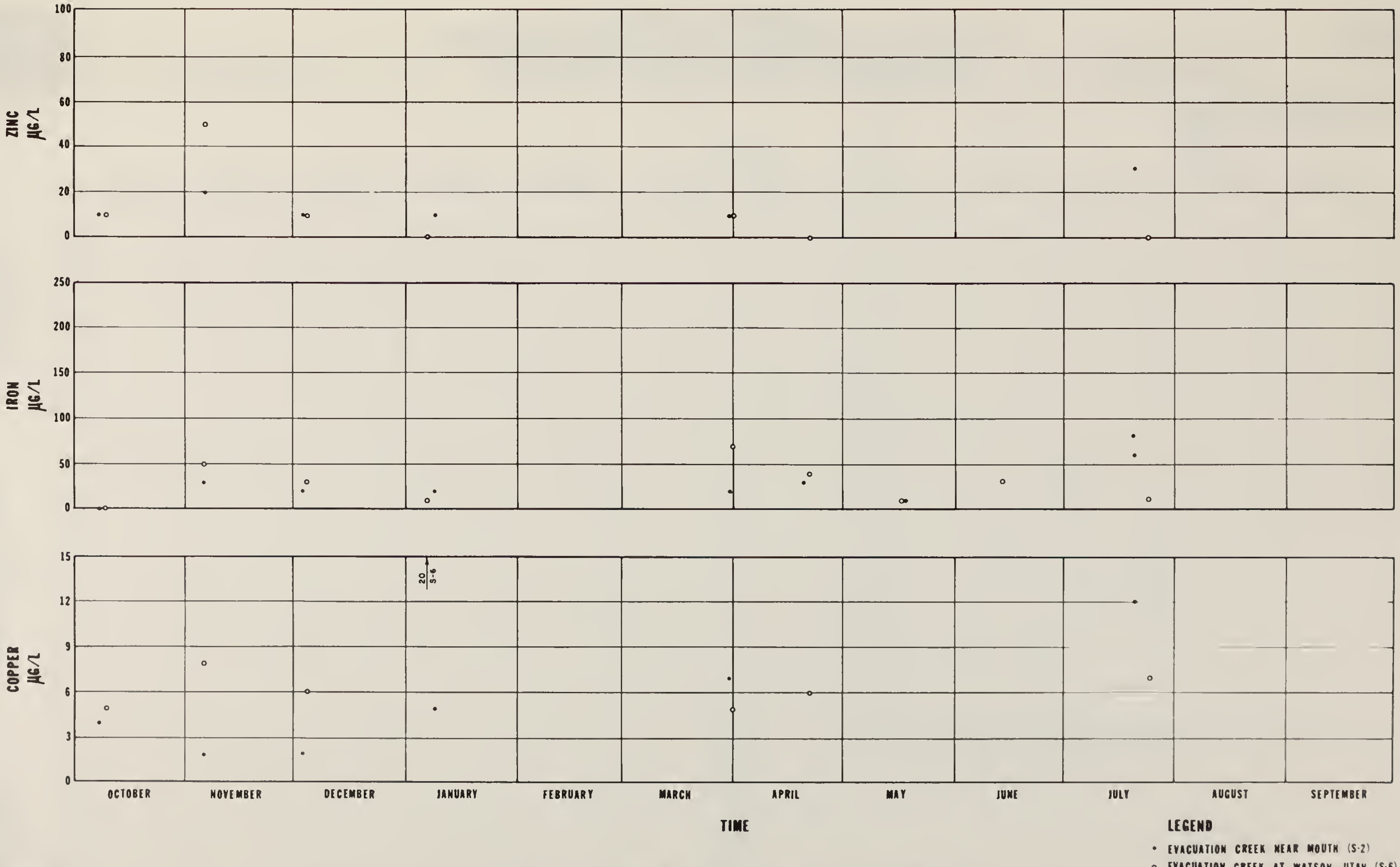
FIGURE II-11



VARIATION IN TIME OF REPRESENTATIVE NUTRIENTS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)
OCTOBER 1975 - SEPTEMBER 1976

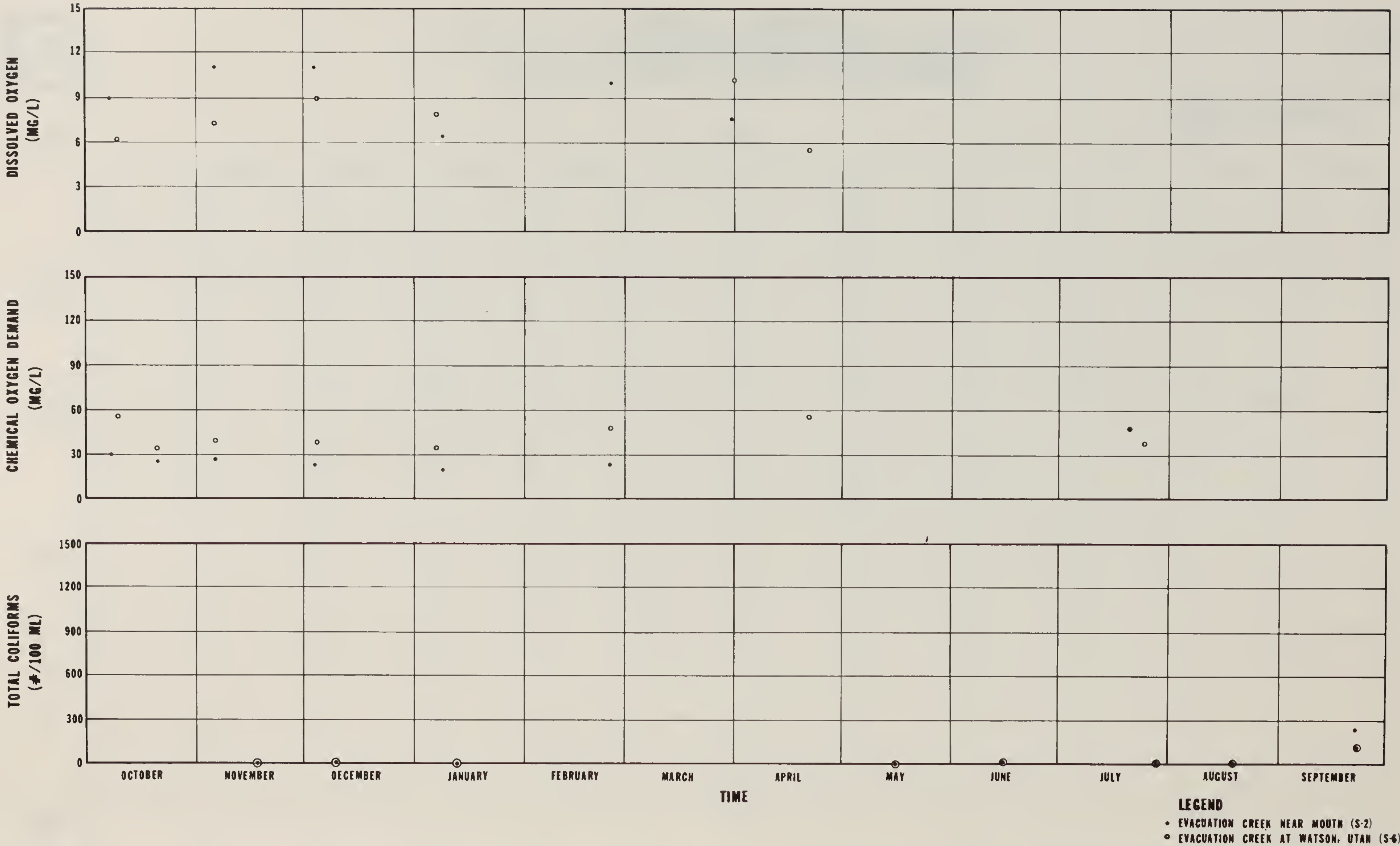
FIGURE II-12



VARIATION IN TIME OF SOME TRACE ELEMENTS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)
OCTOBER 1975 - SEPTEMBER 1976

FIGURE II-13

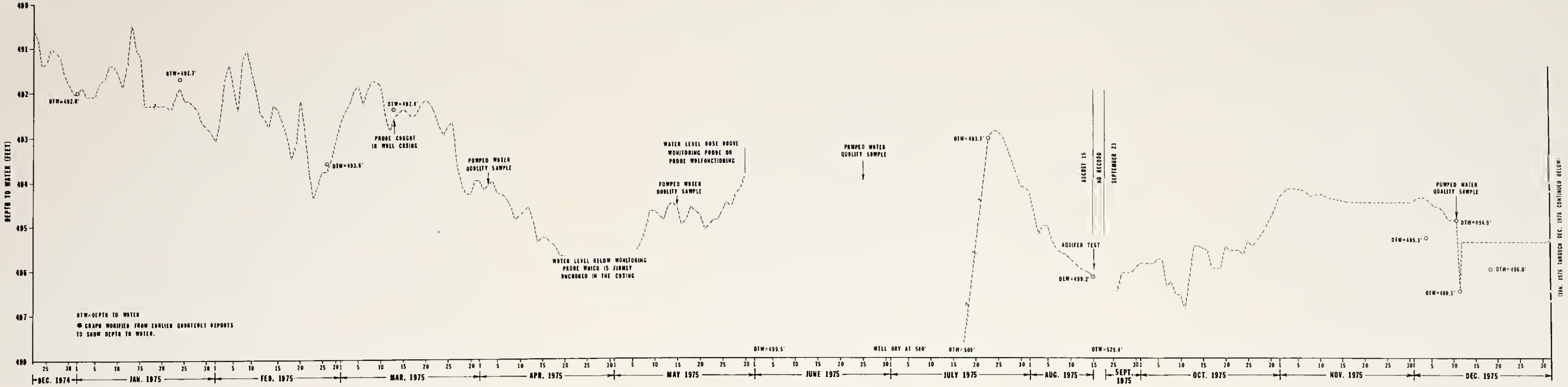


VARIATION IN TIME OF BIOCHEMICAL CONSTITUENTS

EVACUATION CREEK NEAR MOUTH (S-2) AND EVACUATION CREEK AT WATSON, UTAH (S-6)

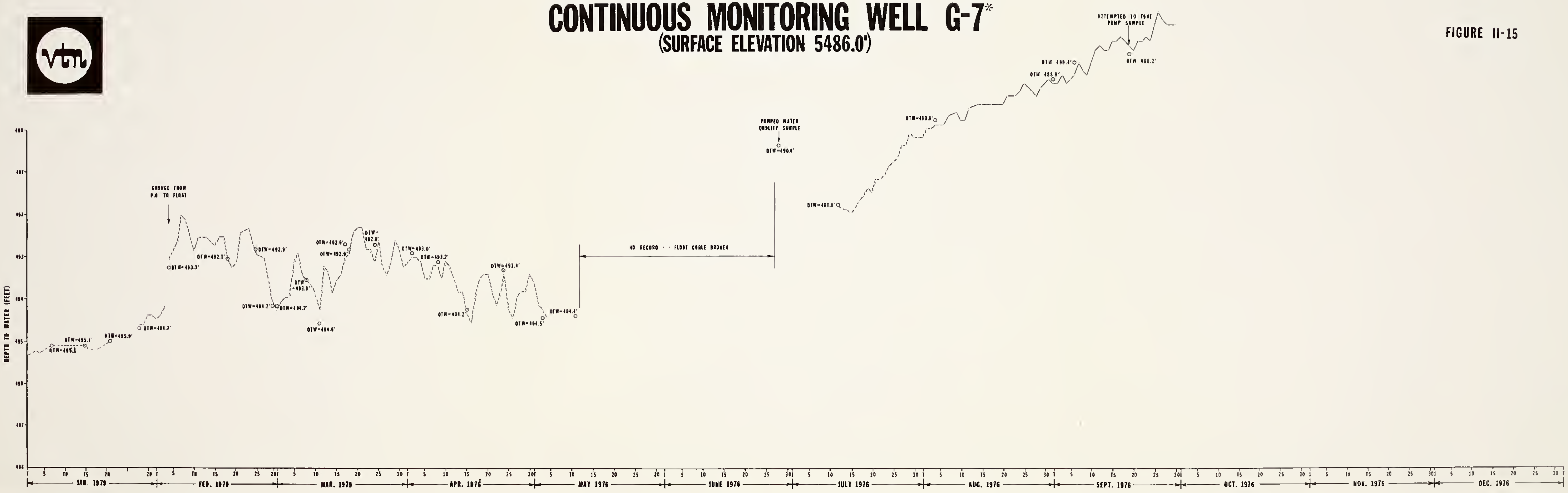
OCTOBER 1975 - SEPTEMBER 1976

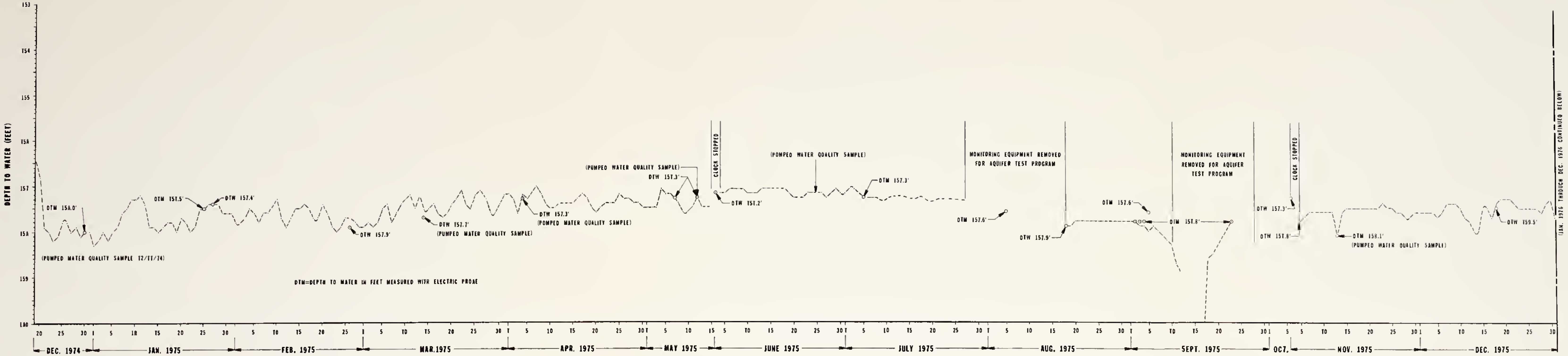
FIGURE II-14



CONTINUOUS MONITORING WELL G-7*
(SURFACE ELEVATION 5486.0')

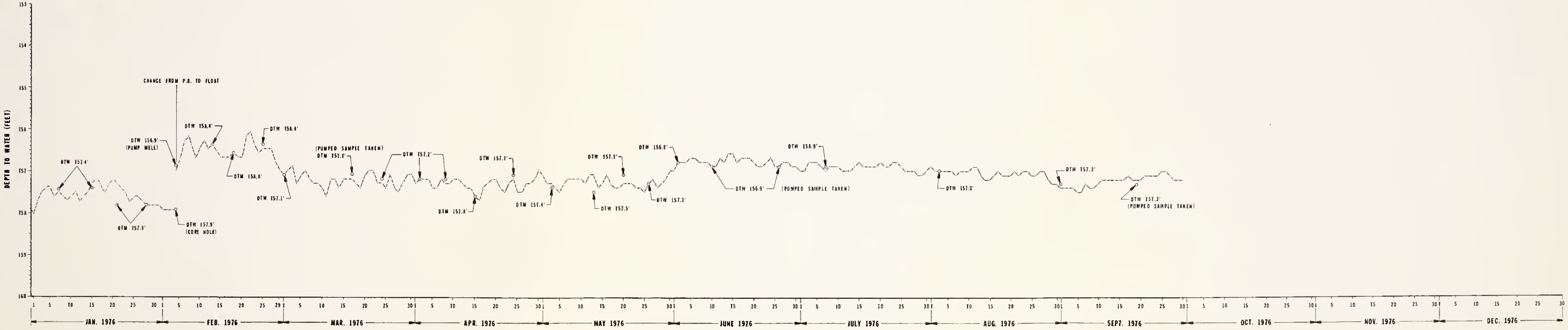
FIGURE II-15

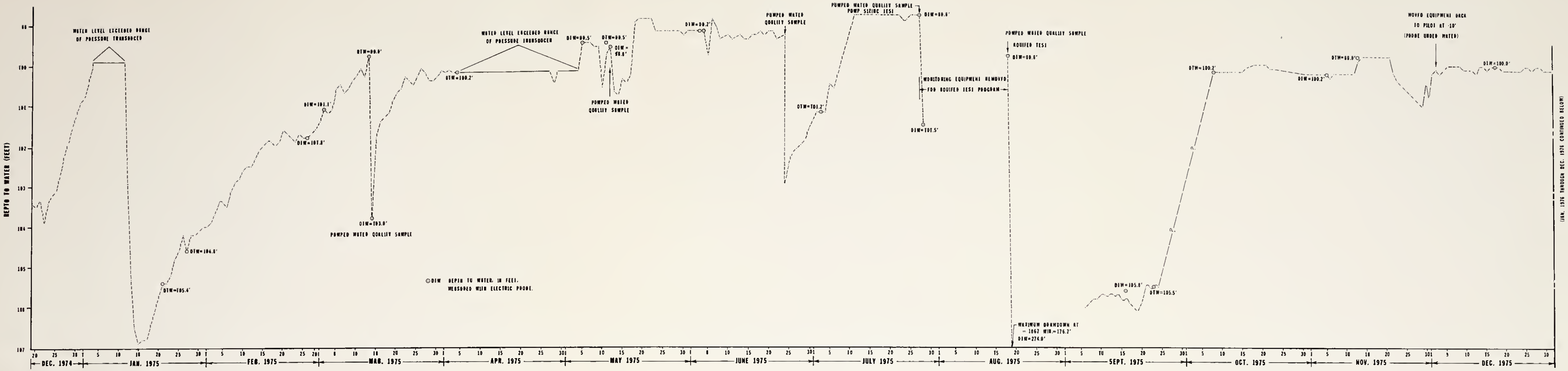




CONTINUOUS MONITORING WELL P-2 LOWER
(SURFACE ELEVATION 4991.0')

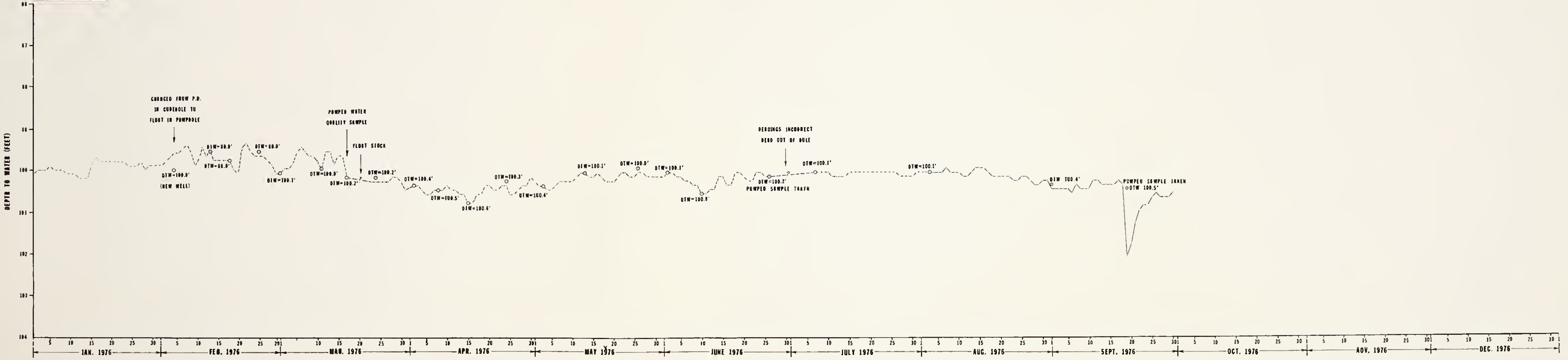
FIGURE II-16





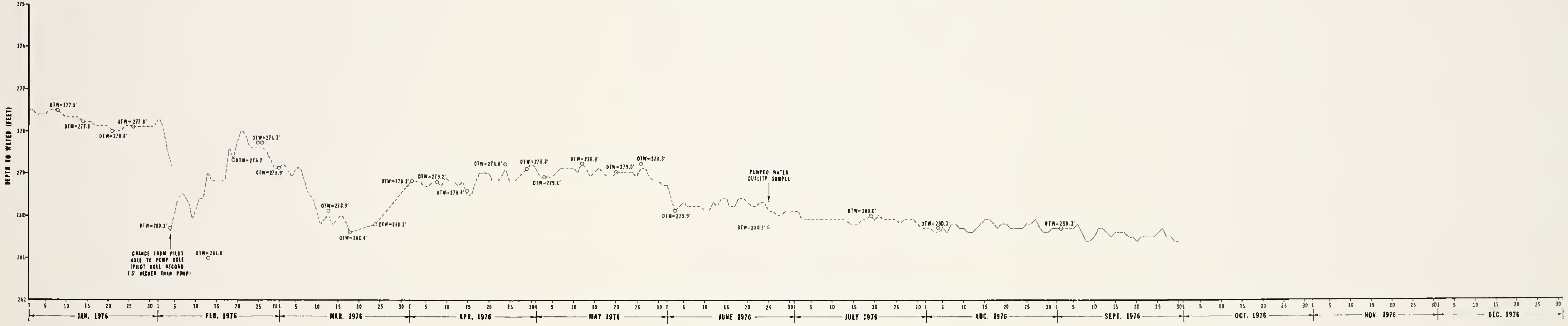
CONTINUOUS MONITORING WELL P-2 UPPER
(SURFACE ELEVATION 4991.0')

FIGURE II-17



CONTINUOUS MONITORING WELL P-1
(SURFACE ELEVATION 5284.0')

FIGURE II-18



C. WORK SCHEDULED

Data reduction and analysis of the two water years is ongoing for inclusion into the FEBR. The suspension monitoring for water resources was initiated on January 16, 1977, and is fully described in the Work Plan--Lease Suspension Period Environmental Programs-WRSP.

III. AIR RESOURCES

A. WORK COMPLETED

During the quarter ending November 30, 1976, meteorology, air quality and radiation were monitored according to the modified stipulations and conditions for the second year of baseline data collection, as authorized by the Area Oil Shale Supervisor on April 14, and implemented in May. The parameters monitored on the tracts are tabulated by station in Table III-1. In addition to these parameters, samples were collected once a month at Station A-2 for trace-metal analysis, visibility surveys were conducted once a month at Station A-9 and radiation was monitored at stations A-1 through A-12. One high volume sampler filter per month from Station A-6 was also analyzed for gross alpha and beta radiation levels and for isotope gamma radiation.

All measurement activities continued as established in the modifications. Comprehensive calibrations of all air monitoring instruments were performed in August, and all sulfur analyzers were additionally calibrated in mid-June. In addition to the regular quarterly calibrations of the gaseous pollutant analyzers and the twice annual high volume sampler calibrations, zero and span checks are made for most air-quality monitoring instruments once every 3 days.

The data collected from August 1, 1976 through October 31, 1976 is tabulated in Table III-2. (Data processing lead times result in a one-month offset from the September-November quarter reporting period for most of the data in this discussion.) The table lists the percentage of hours during the period that data collection was underway for each parameter. Calibration time is counted as data-collection time. Only those parameters specifically listed in the leases (or implied therein) are tabulated. Even though the leases were revised on June 1, 1976 to exclude the percentage monitoring criteria, tabulating percentages is continued as done in previous reports. The original leases stated that "...the Lessee shall monitor air quality over at least 90 percent of each lease year..." Table III-2 shows that air quality monitoring took place 100% of the August-October period, while any given parameter was monitored at least 91% of the hours of this period. For meteorology, the leases stated that, "...the Lessee shall establish a meteorological station...to monitor, at least 95 percent of the time over each lease year..." Again, meteorology was monitored 100% of the August-October period at a number of stations, well in excess of the one per tract specified in the leases, and monitoring of any given parameter was performed 100% of the hours of this quarter.

TABLE III-1

AIR RESOURCES PARAMETERS MEASURED BEGINNING MAY 1976

Parameters Measured \ Sites	A-2	A-3	A-4	A-6	A-7	A-10	A-11	A-13
WS-WD 10 m	X	X	X	X	X	X	X	X
WS-WD 20 m	X			X				
WS-WD 30 m	X			X				
Temp. 10 m	X		X	X		X	X	X
Δ Temp. (30-10 m)	X			X				
Humidity	X			X				
σ_θ, σ_w -10 m			X					
σ_θ, σ_w -30 m	X			X				
Pressure				X				
Net Radiation				X				
SO_2		X	X	X	X			
H_2S		X	X	X	X			
TS		X	X	X	X			
CO				X				
HC				X				
CH_4				X				
O_3				X				
NO_2				X				
Part.		X	X	X	X			
Scat. Coeff.	X							

TABLE III-2

PERCENTAGE OF TIME MONITORING WAS PERFORMED DURING THE PERIOD AUGUST 1 - OCTOBER 31

Component	Number of Stations	Percentage
H_2S	4	100
SO_2	4	100
Susp. Particulates	4	100
HC, CO	1	91
NO_x	1	95
O_3	1	98
Wind (10 m)	8	100
Wind (20 m)	2	100
Wind (30 m)	2	100
Temp. (10 m)	6	100
Δ Temp. (30-10 m)	2	100
Rel. Hum.	2	100

B. DATA SUMMARY

In general, conditions observed on the tracts during this period compare well with those for the comparable period in 1975.

1. SURFACE METEOROLOGY

Typical airflow patterns observed on the tracts during the early morning (0400-0600 MST) and afternoon (1400-1600 MST) in this quarter are presented in figures III-1 and III-2. The solid arrows are wind vectors at monitoring sites, and the longer lines are estimated flow streamlines. In the early morning hours, airflow was of the drainage type, flowing toward low terrain and down the White River channel, as has been observed throughout the monitoring program. The afternoon winds were more organized and were dominated by the synoptic scale pressure gradient. A general west-to-east airflow pattern can be recognized throughout the tracts.

The average wind speed on the tracts in October 1976 was slightly less than in October 1975. This is attributed to fewer storms that traversed the area. In general, winds were about 2.0 m/s (4.5 mph) at night and 3.5 m/s (8 mph) in the afternoon, with higher speeds during the passage of fronts.

Figure III-3 shows directional wind roses at all wind stations on the tracts. The predominance of drainage type winds is clearly shown. Spatial variation in wind speed and wind direction over the tracts, a result of the complex terrain features in the area, is shown in figures III-1, III-2, and III-3. Generally, wind speeds over the ridges and widely exposed terrain were higher than wind speeds in protected valleys.

Figure III-4 shows the diurnal variation in temperature in October at Station A-6. Average nighttime values were around 2°C, and average afternoon values were around 15° C. The daily maximum temperature was generally observed at 1400-1600 MST, and the daily minimum temperature was observed between 0500-0700 MST. On the tracts, temperatures were usually lower in protected valleys than in open terrain.

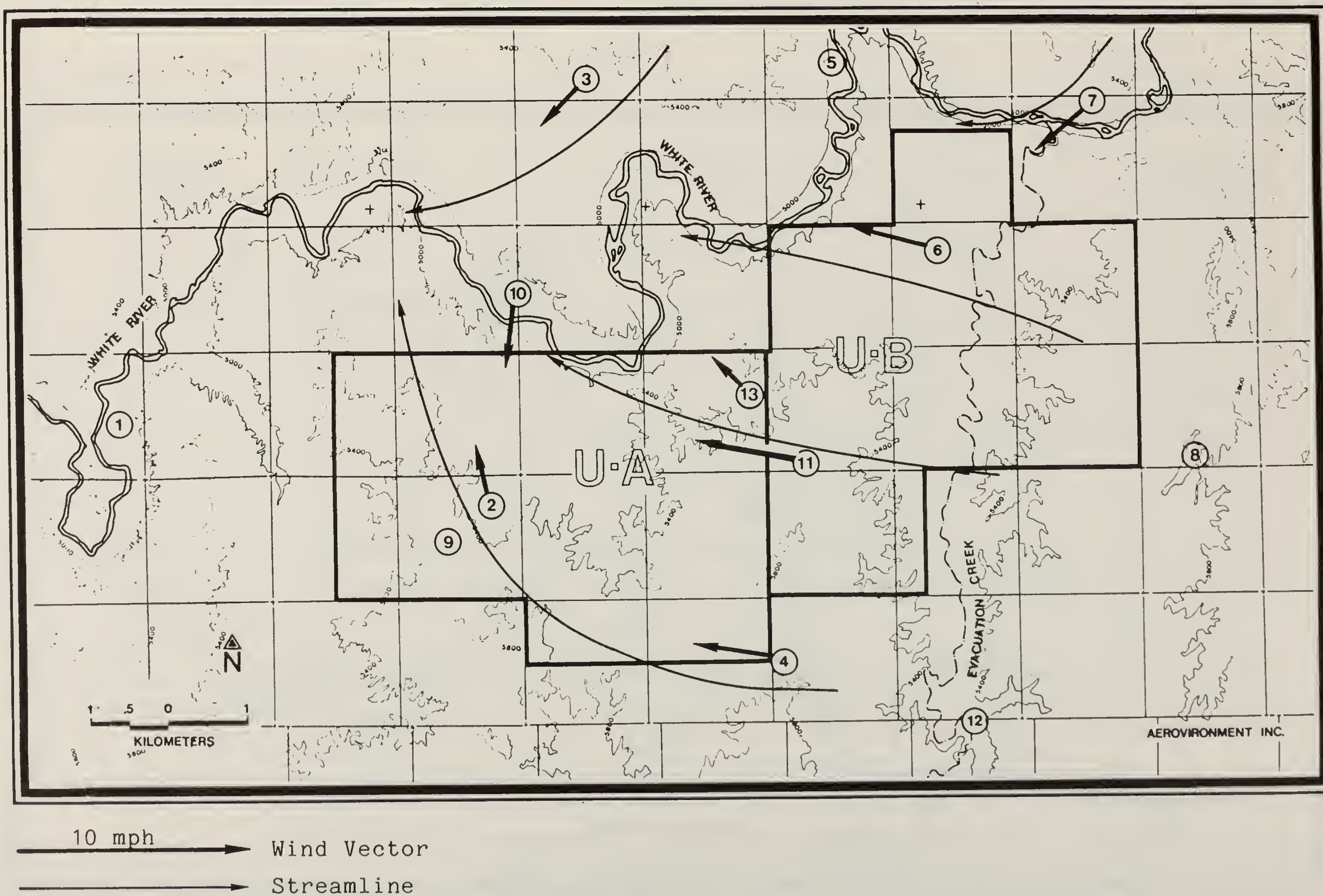
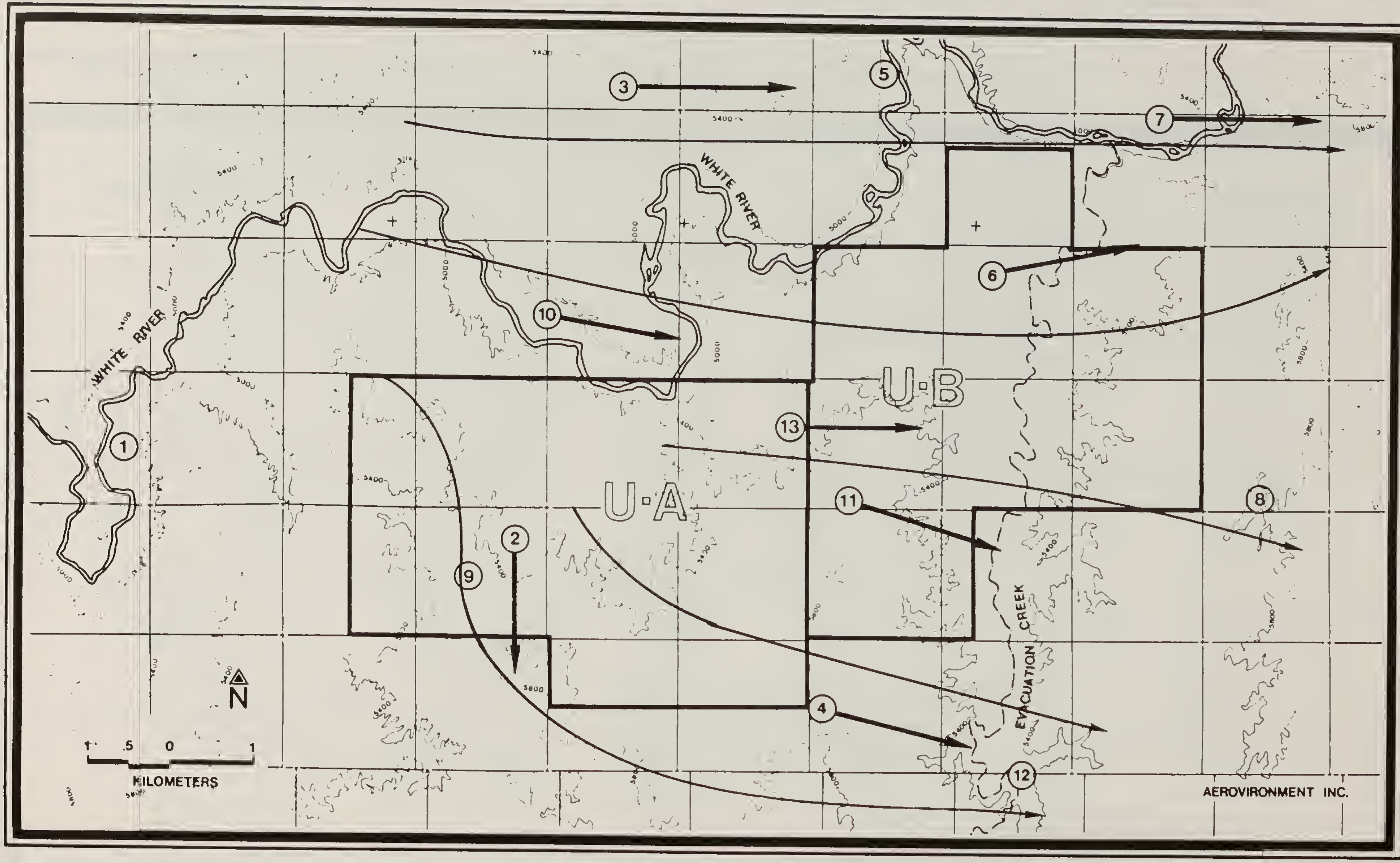


FIGURE III-1. TYPICAL MORNING AIRFLOW PATTERN ON TRACTS U-a AND U-b IN OCTOBER 1976.

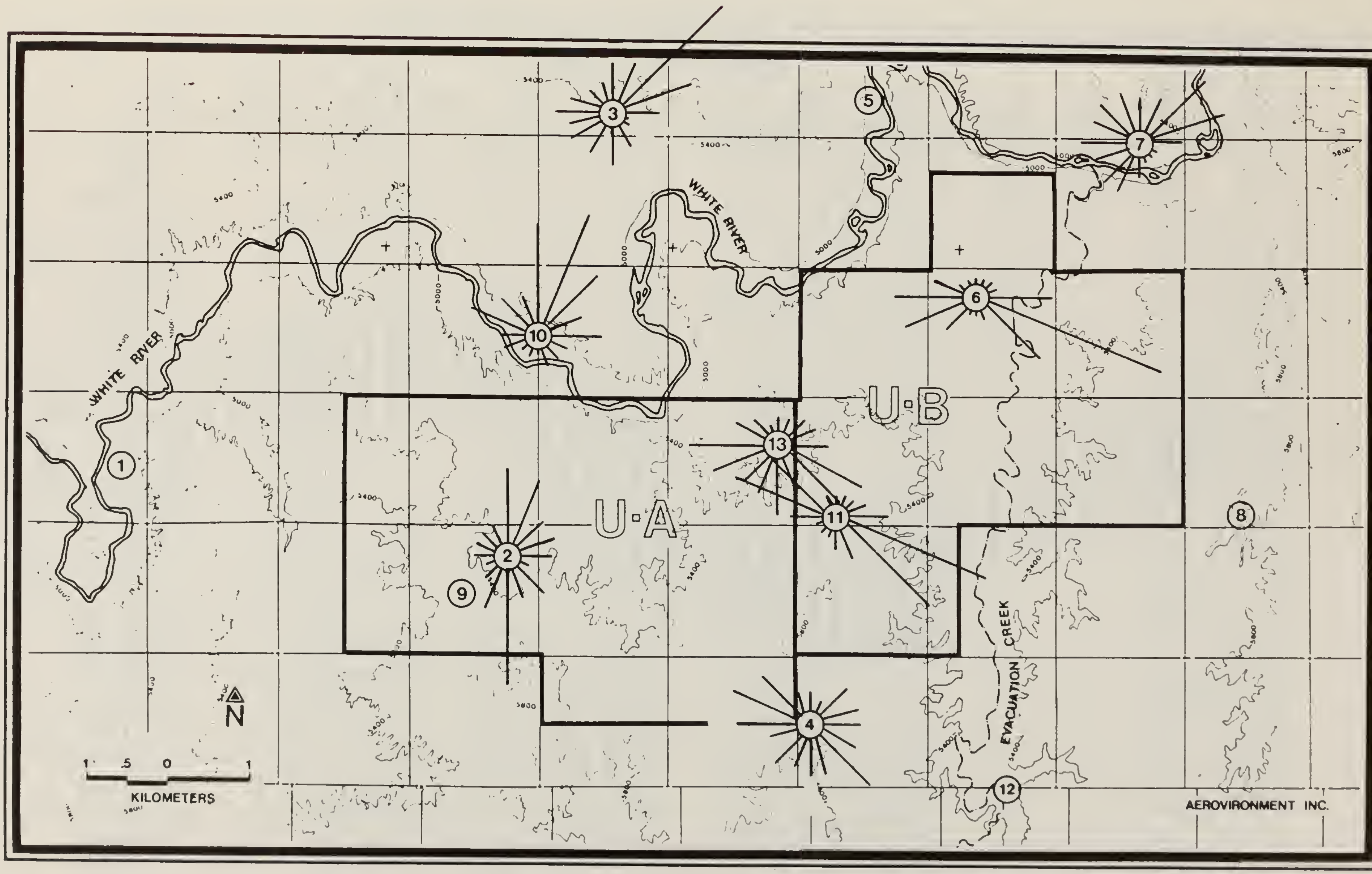


10 mph

Wind Vector

Streamline

FIGURE III-2. TYPICAL AFTERNOON AIRFLOW PATTERN ON TRACTS U-a AND U-b IN OCTOBER 1976.



0 25
% of occurrences

FIGURE III-3. DIRECTIONAL WIND ROSES AT THE MONITORING STATIONS ON THE TRACTS FOR OCTOBER 1976. The length of each bar represents the frequency of winds from the direction toward which the bar points.

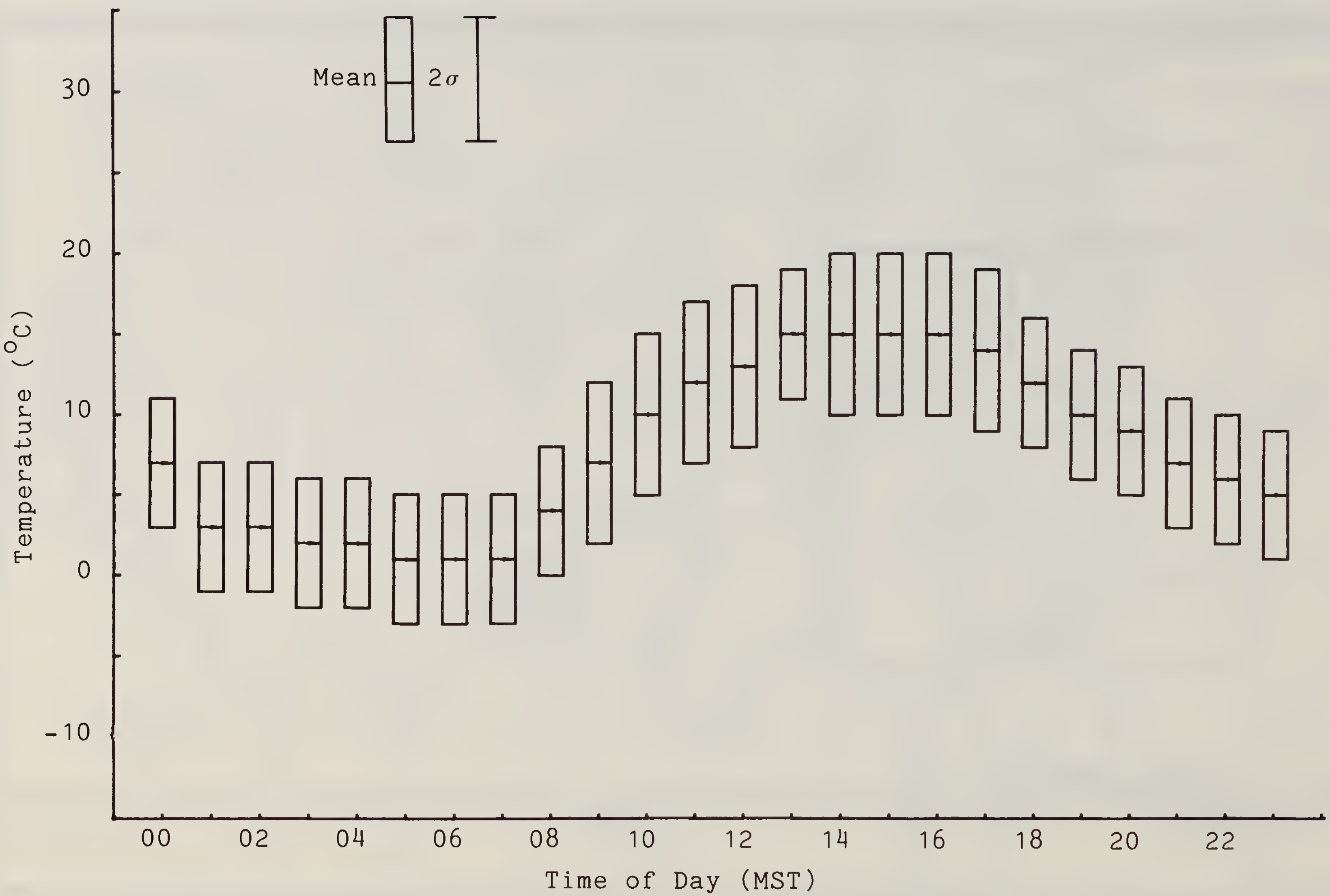


FIGURE III-4. DIURNAL VARIATION OF MEAN TEMPERATURES AND THEIR STANDARD DEVIATIONS AT STATION A-6 IN OCTOBER 1976.

The diurnal variation in relative humidity in October at Station A-6 is plotted in Figure III-5. Nighttime relative humidity was around 60% and afternoon relative humidity was about 30%. The diurnal trend is a mirror image of the temperature plot in Figure III-4, which indicates that the amount of water vapor in the air remains constant during the day.

2. AIR QUALITY

a. Gaseous Pollutants

Sulfur dioxide and H_2S are monitored at four stations on the tracts. In addition, CO, HC, NO_2, and O_3 are monitored at Station A-6. There are no state air quality standards for gaseous pollutants, but there are federal standards for all components except H_2S. For reference in the ensuing discussion, Table III-3 presents the Federal Ambient Air Quality Standards (AAQS) for the various gaseous pollutants monitored on the tracts. For H_2S, a reference for interpreting the data is the California 1-hour standard of 42 $\mu g/m^3$ (.03 ppm).

The air quality has consistently been very good on the tracts, which would be expected because of their remote location. Except for sporadic occurrences of high non-methane hydrocarbon (NMHC) the air on the tracts this quarter was very clean with respect to gaseous pollutants. The only other pollutant that was present in measurable quantities was ozone, which has a natural non-zero background level. Otherwise, almost all instruments measuring gaseous pollutants were recording at their threshold limit most of the time.

A plot of diurnal variations of ozone at Station A-6 in October is shown in Figure III-6. The average diurnal trend consisted of low readings of about 30 $\mu g/m^3$ (0.015 ppm) between 0600-0700 in the early morning hours and higher values of 70 $\mu g/m^3$ (0.036 ppm) between 1200-1700 in the afternoon. The air quality standard was not exceeded. Very little diurnal variation was observed for all other pollutants.

Table III-4 shows the peak and second highest values as well as the percentage of observations exceeding standards, for all gaseous pollutants observed in October. The values are shown for the time averages for which air quality standards exist. The data presented are representative of the worst air quality situation on the tracts during this season. All of them, except ozone and NMHC values, are near the detection thresholds of the instruments.

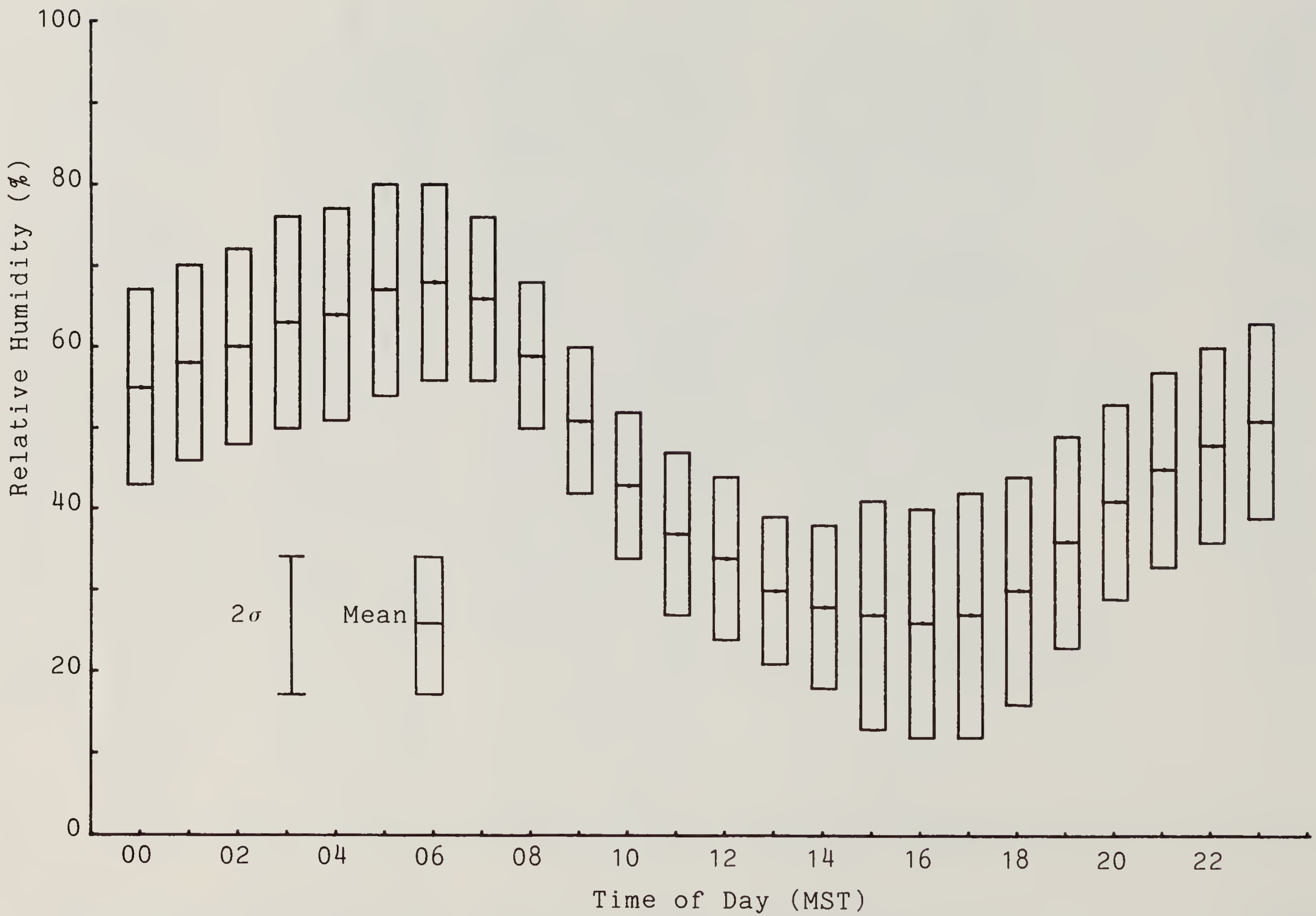


FIGURE III-5. DIURNAL VARIATION OF MEAN RELATIVE HUMIDITY READINGS AND THEIR STANDARD DEVIATIONS AT STATION A-6 DURING OCTOBER 1976.

TABLE III-3

FEDERAL AIR QUALITY STANDARDS FOR GASEOUS POLLUTANTS

Pollutant	Averaging Time	Primary Standards	Secondary Standards
Ozone (O_3)	1 hour	160 $\mu g/m^3$ (0.08 ppm)	Same as primary
Carbon Monoxide (CO)	8 hours	10 mg/m^3 (9 ppm)	Same as primary
	1 hour	40 mg/m^3 (35 ppm)	Same as primary
Sulfur Dioxide (SO_2)	Annual Average	80 $\mu g/m^3$ (0.03 ppm)	-
	24 hour	365 $\mu g/m^3$ (0.14 ppm)	-
	3 hour	-	1300 $\mu g/m^3$ (0.5 ppm)
Nitrogen Dioxide (NO_2)	Annual Average	100 $\mu g/m^3$ (0.05 ppm)	Same as primary
Hydrocarbons (corrected for methane - NMHC)	3 hour (6-9 a.m.)	160 $\mu g/m^3$ (0.24 ppm)	Same as primary

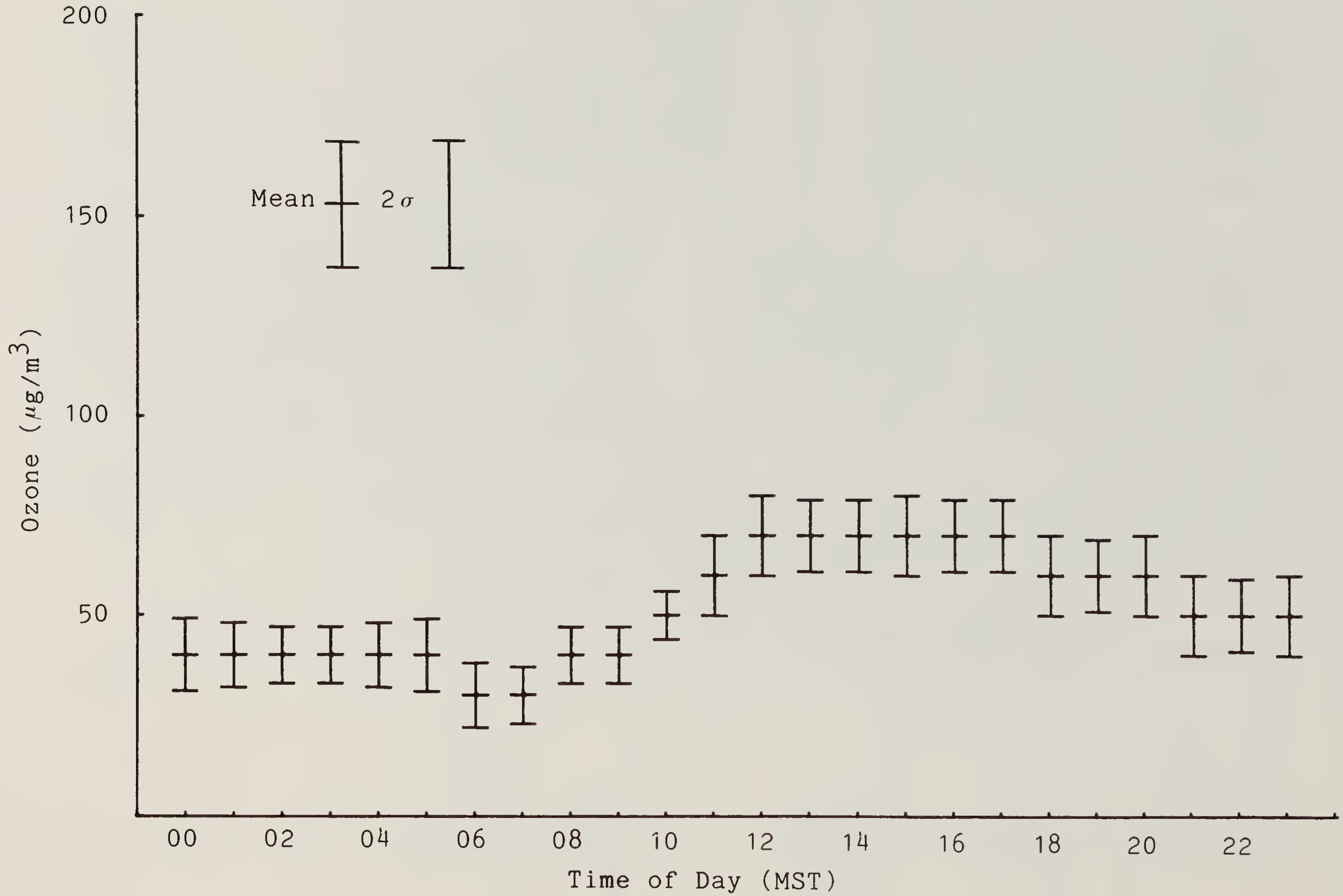


FIGURE III-6. OZONE CONCENTRATIONS. Diurnal variation in mean ozone concentrations with their standard deviations at Station A-6 during fall, based on data for the central month of the quarter (October 1976).

TABLE III-4

PEAK GASEOUS POLLUTANT CONCENTRATIONS

The peak and second highest values as well as the percent of observations exceeding standards for all gaseous pollutants observed on the tracts in October 1976.

Pollutant	Average Time	Peak Conc.	Second Highest Conc.	Average	Standard	Percent Exceedance of Standard
O_3 ($\mu g/m^3$)	1 Hour	90	90	50	160	0
CO (mg/m^3)	8 Hours	.3	.3	.1	10	0
	1 Hour	1.2	1.1	0.1	40	0
SO_2 ($\mu g/m^3$)	24 Hours	25	25	5	365	0
	3 Hours	34	34	5	1300	0
	1 Hour	35	35	5	-	-
H_2S ($\mu g/m^3$)	1 Hour	20	20	0	-	-
NO_2 ($\mu g/m^3$)	1 Hour	20	20	10	-	-
NMHC ($\mu g/m^3$)	3 Hour (6-9 A.M.)	130	113	33	160	0

The air quality levels in this quarter compare well with those in the same period in 1975 except for O_3 and NMHC. For these two pollutants, readings were slightly lower in 1976 than in 1975.

b. Particulates and Trace Metals

Particulate concentrations on the tracts are monitored by high volume samplers that sample over a period of 24 hours once every six days simultaneously at four air monitoring stations. The size of particulates collected by the samplers range from below 1 μm to somewhat above 25 μm.

Table III-5 gives the geometric mean, standard geometric deviation, maximum, and minimum of particulate concentrations in $\mu g/m^3$ at the four stations in the fall quarter. Data collected between September 1 through November 30, 1976 were used.

The geometric mean of particulate concentrations (which can be considered to correspond to the concentration medium) ranged from 13.5 $\mu g/m^3$ at Station A-3 to 37.1 $\mu g/m^3$ at Station A-6. There was noticeable spatial variation on the tracts, with Station A-6 monitoring the highest particulates. Concentrations at all sites were generally high on days with high winds.

None of the recorded values exceeded federal or state standards, which are shown in Table III-6. The most stringent short-term standard is the National Secondary Standard, which sets the upper limits at 150 $\mu g/m^3$ averaged over 24 hours; this is not to be exceeded more than once a year.

A set of size fractionated particulate samples was collected every month at Station A-2 by means of a Multistage Lundgren impactor for analysis of trace elements using ion-excited x-ray emission techniques at 50 microcoulombs. Analysis results of the last sample of last quarter and the first sample of this quarter are presented in Table III-7. Other samples collected during this quarter are being analyzed.

With the exception of normal soil constituents, most of the elements shown on Table III-7 were found at concentrations of less than or around 10 ng/m^3, with most of the mass generally found in the smaller size fractions. The elements found in larger quantities were Al, Si, S, K, Ca, and Fe. Concentrations of typical anthropogenic aerosols such as Cu, Zn and the automotive-derived aerosols of Br and Pb were very low, only a few percentage of typical urban values.

TABLE III-5

PARTICULATE CONCENTRATIONS

The geometric mean, standard geometric deviation, maximum and minimum of particulate concentrations ($\mu g/m^3$) at Stations A3, A4, A6, and A7 in the fall quarter (September 1 through November 30, 1976).

Station	Geometric Mean	Standard Geometric Deviation	Maximum	Minimum
A-3	13.5	1.7	25.3	5.2
A-4	17.0	1.7	34.6	6.0
A-6	37.1	1.9	101.2	7.6
A-7	16.6	1.8	42.1	5.3

TABLE III-6

AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER ($\mu g/m^3$).

Pollutant	Averaging Time	Utah Standards	National Standard	
			Primary	Secondary
Suspended Particulate Matter	Annual Geometric Mean	90	75	60
	24 Hour	200	260	150

TABLE III-7

TRACE ELEMENTS DETECTED AT STATION A-2
USING ION-EXCITED X-RAY EMISSIONS TECHNIQUE

Any elements not shown have not been detected.

Sampling Record	Sensitivity of Analysis	Size (μm) Range	Be	B	Na	Mg	Al	Si	S	Cl	K	Ca	Ti	V	Mn	Fe	Ni	Cu	Zn	As	Se	Br	Rb	Sr	Zr	Ba	Pt	Au	Hg	Pb	Cr
8/5-8/17	50 μC	3.6-20.0	-	-	B	B	C	D	A	A	B	C	A	*	A	B	*	*	*	-	-	*	-	-	-	A	A	-	A	A	*
		0.65-3.6	-	-	A	A	B	D	B	A	B	B	A	*	A	B	*	*	A	-	-	*	-	-	-	*	A	_	A	A	*
		0.10-0.65	-	-	A	A	A	C	D	A	B	B	A	A	*	B	A	A	A	-	-	A	-	-	-	A	-	A	-	B	A
9/6-9/18	50 μC	3.6-20.0	A	-	A	A	B	C	A	A	C	B	A	A	A	C	A	A	A	-	-	A	-	-	-	-	-	-	A	A	A
		0.65-3.6	A	-	A	A	C	D	C	A	B	C	A	A	A	B	A	A	A	-	-	A	-	-	-	-	-	-	-	A	A
		0.10-0.65	-	-	B	A	B	B	D	A	B	B	A	A	A	B	A	A	A	-	-	A	-	-	-	-	-	-	-	A	A
10/3-10/17	50 μC	3.6-20.0	-	-	A	A	B	E	A	A	B	D	A	A	A	C	A	A	A	-	-	A	-	-	-	A	-	-	A	A	A
		0.65-3.6	-	-	A	A	B	D	C	A	B	C	A	A	A	C	A	A	A	A	-	A	-	-	-	A	-	-	A	A	A
		0.10-0.65	-	-	B	A	A	B	D	A	B	B	A	A	A	C	A	A	A	-	-	A	-	-	-	B	-	-	-	B	A

-	Element not found
*	Concentration < detection limit
A	10 ng/m^3 > concentration > 0 ng/m^3
B	50 ng/m^3 > concentration ≥ 10 ng/m^3
C	100 ng/m^3 > concentration ≥ 50 ng/m^3
D	500 ng/m^3 > concentration ≥ 100 ng/m^3
E	Concentration ≥ 500 ng/m^3

c. Visibility

The clarity of the atmosphere on the tracts is monitored by three methods: (1) continuous recording of light scattering coefficient with an integrating nephelometer at Station A-2; (2) photographic recording of visibility on color and monochromatic film from an observation point above Station A-9; and (3) visual observations while the photographic records are being made.

The integrating nephelometer recorded an average scattering coefficient of $0.04 \times 10^{-3} m^{-1}$ during this quarter, which corresponds to a local visual range (assuming a 2% contrast threshold for the eye) of 120 km (75 miles). The highest scattering recorded was $b_s = 0.09 \times 10^{-3} m^{-1}$, which corresponds to a local visual range of 55 km (34 miles), and which was observed between the hours 0100 through 0500 on October 25, 1976. The most clear hours had $b_s = 0.02 \times 10^{-3} m^{-1}$ (visual range 200 km, or 125 miles), which was observed at 2000-2100 on October 9, 1976. All observed values have corresponded to extremely clear, background quality air. A very weak diurnal variation in scattering coefficient was observed, with the night and early morning hours showing slightly higher scattering (lower visibility) than the afternoon and evening hours.

Photographic visibility measurements were made on September 3, October 1, and November 5. No significant obstructions to visibility were recorded. The photographically derived visibilities and those computed from the integrating nephelometer measurements correlate well, indicating as before that the Uinta Basin air mass is relatively homogeneous and that the localized nephelometer measurements are representative of a large area.

3. RADIATION

Continuous monitoring of ambient radiation was performed by thermoluminescent dosimeters at stations A-1 through A-12 during the quarter. The radioactivity dosages measured from August 19 -November 18 are tabulated on Table III-8. The readings, which ranged from 9 mR to 14 mR, are all in the normal ambient range and agree with measurements made in previous quarters.

Particulate matter collected by high volume sampler filters at A-6 during August-October 1976 was analyzed for radiation by a gross alpha and beta measurement and an isotopic gamma radiation scan. The results showed all radioactive isotope

TABLE III-8

RADIATION LEVELS

Average radiation levels at all stations during August 19-November 18, 1976, as measured by three thermoluminescent dosimeters at each station.

A-1 - 10 mR	A-7 - 11 mR
A-2 - 12 mR	A-8 - 10 mR
A-3 - 10 mR	A-9 - 11 mR
A-4 - 13 mR	A-10 - 10 mR
A-5 - 9 mR	A-11 - 14 mR
A-6 - 13 mR	A-12 - 12 mR

activities to be in the background range. Gross alpha and beta scans were all below 0.1 pCi/m^3. Qualitative gamma scans revealed the presence of Cs^{137}, Be^7, and Pb^{212} on all filters. In addition, Pb^{214} and Ra^{226} were detected on the filter taken on September 3 while Pb^{214}, Ra^{226}, Bi^{214}, Ce^{141} and Ce^{144} were present on the filter taken on October 3. With the exception of Ra^{226}, which showed readings of less than 0.35 pCi/m^3, all readings were below 0.1 pCi/m^3.

C. WORK SCHEDULED

Routine baseline monitoring of all air resources data will continue through January 15, 1977, with suspension monitoring beginning January 16, 1977.

The objectives of the suspension monitoring program are to provide continuity and support of the data collection effort and findings of the two year environmental baseline program. The monitoring program proposed for the suspension period is described in the Work Plan - Lease Suspension Period Environmental Programs-WRSP on file at the AOSSO.

IV. BIOLOGICAL RESOURCES

A. WORK COMPLETED

1. VEGETATION

Data collected and summarized during the ninth quarter--September 1 to November 30, 1976--included phenological data for the 1976 growing season, sagebrush stem measurements for fall 1976, and data concerning general observations on vegetation use and conditions in late October.

2. TERRESTRIAL VERTEBRATES

a. General

Flushing transects and trapping grids were run in October as scheduled.

b. Mule Deer

One deer was monitored successfully in September of this quarter. All other transmitters have ceased functioning. Pre-season observations of doe-fawn ratios were conducted during September and October.

c. Canada Geese

A final float trip was conducted in September to monitor water fowl populations on the White River.

d. Beaver

Beaver caches were counted in September to monitor populations and activity on the White River.

e. Coyote

Coyote scats were collected throughout the quarter.

3. TERRESTRIAL INVERTEBRATES

Quantitative samples collected during June, July, August, and September were examined, determined to the species level, and counted. Tables and analysis of the data will be included in the FEBR. This will include unified lists of all insects counted in the tables, with codes indicating the plants on which they were collected.

4. AQUATIC BIOLOGY

The final complete sampling was conducted in August 1976, and final periphyton samples were collected in late October 1976.

5. MICROBIOLOGY

Laboratory analyses and analyses of results continued through the quarter.

B. DATA SUMMARY

1. VEGETATION

a. Phenological Observations in 1976

The 20 photoplots (5 plots in each of the 4 vegetation types: sagebrush-greasewood, juniper, shadscale, and riparian) established in fall 1974 were observed for phenological conditions in 1976. The species in each plot were observed every other month starting March 22, 1976, until November 20, 1976. Twenty-seven phenological descriptions were recorded in the study.

The computer printout results of the phenological observations for March, May, July, September, and November 1976 are included in the field data package by vegetation type on each observation date. Since not all species appeared in each of the five photoplots within a vegetation type, the percent of

a species in a given phenological condition is a mean based on the number of plots in which the species occurred.

During phenological-data collection, the soil moisture potential, soil temperature, and soil surface temperature were recorded at each phenological plot. The soil water potential was 30 cm for March, May, July, September, October, and November (Table IV-1); the general average plus the standard deviation is given for each vegetation type. The soil temperature was 30 cm for only May, July, September, and November (Table IV-2); the average temperature and standard deviation is given for each vegetation type. The average and standard deviation for soil surface temperatures are listed on Table IV-3. It is important to keep in mind that since this parameter is dependent upon incident solar radiation, the parameter varies according to time of day, slope and exposure, and whether the sky is cloudy or clear.

b. Sagebrush Stem Growth, 1976

Stem length was measured in 180 sagebrush plants distributed over Tracts U-a and U-b. The length of growth was assumed to be a measure of site favorability for growing conditions for 1976. The measurements were also made as a preliminary evaluation of environmental influences (temperature, soil moisture, light, air quality) on plant growth. In subsequent years the measurements will be made on a treatment-control basis, with plants sampled in the proximity of the industrial site and in areas far removed from its influence. (See previous quarterly reports for the map of sampling sites and the methods for selection and measurement.)

Data concerning stem lengths in late October 1976 from six sampling sites are reported in the field data package. Twenty plants per site were examined. Means, variance per plant, and variance per site are shown. Table IV-4 shows average leader length for sites and year.

Observations of site conditions at the time of sampling indicate extremely dry conditions. Some browsing on shrubs, including sagebrush, was evident. Emergency, or stress, browsing (by small mammals it is assumed) was noted on greasewood, broom snakeweed, prickly pear cactus, rabbitbrush, and Indian ricegrass stem bases. This appeared to be caused by the very dry fall of 1976.

TABLE IV-1

SOIL WATER POTENTIAL AT 30 CM DEPTH, 1976

Date	Sagebrush-Greasewood	Vegetation Type Juniper	Shadscale	Riparian
3-22-76	0 ± 0*	0 ± 0	-2 ± 2.3	0 ± 0
5-21-76	-7.6 ± 4.8	-2.2 ± 2.7	-17.4 ± 8.4	-2 ± 1.2
7-14-76	-34.6 ± 8.1	-38.8 ± 13.5	-49.6 ± 28.2	-13.8 ± 2.2
9-23-76	-50.6 ± 22.4	-42 ± 22.7	-48.1 ± 19.4	-15.4 ± 7.8
11-19-76	-67.8 ± 8.8	-52.6 ± 15	-49.4 ± 19.6	-17 ± 7.7

*Data expressed as bars ± standard deviation.

TABLE IV-2

SOIL TEMPERATURES AT 30 CM DEPTH

Date	Sagebrush-Greasewood	Vegetation Type Juniper	Shadscale	Riparian
3-22-76	---Data taken incorrectly---			
5-21-76	18.4 ± .55*	16.2 ± 1.1	20.6 ± 2.9	14 ± 3.1
7-14-76	26.6 ± .89	26.2 ± 1.9	24 ± 2.1	23.4 ± 3.5
9-23-76	19.6 ± .54	16.2 ± 1.3	20.4 ± 1.9	19.6 ± 2.4
11-19-76	5.6 ± .55	4.2 ± .83	5.8 ± 1.6	6.25 ± .5

*Data expressed as °C ± standard deviation.

TABLE IV-3

SOIL SURFACE TEMPERATURE - 1976

Date	Vegetation Type Sagebrush-Greasewood	Juniper	Shadscale	Riparian
3-22-76	---Data not taken---			
5-21-76	22.2 ± 4.8*	20.6 ± 2.7	20.6 ± 2.9	18.8 ± 8.8
7-14-76	44.2 ± 3.0	36 ± 1.4	30.4 ± 4.5	29.8 ± .5
9-23-76	15.6 ± 9.0	24 ± 9.1	24.8 ± 1.1	25 ± 3.5
11-19-76	0.6 ± 4.4	1.4 ± 5.1	12.6 ± 4.5	7.8 ± 2.5

*Data expressed as °C ± standard deviation.

TABLE IV-4

SUMMARY OF CURRENT YEAR'S GROWTH OF STEMS AT SIX SITES

Site Location	No.	Mean Length (cm)	Variance(s)
Near G-5, Section 22	1	6.2	1.03
Near G-22, Section 22	2	6.2	1.62
Near Asphalt Wash, Section 29	3	7.0	.89
South of Section 22, Section 35	4	5.5	1.06
Near east end of Tract Ub, Section 18	5	5.4	1.17
North of River, Section 3	6	4.8	1.08
Overall Means		5.9	.82

2. TERRESTRIAL VERTEBRATES

a. General

The number of passerines observed decreased in October, whereas the number of raptors increased. Sandhill cranes accompanied by one whooping crane migrated south over the tracts. Rabbit, rodent, and coyote populations continued to increase. Reptile and amphibian activity was low.

b. Mule Deer

A ratio of 75 fawns:100 does (75%) was obtained. Post-season classification data yielded a ratio of 66 fawns:100 does (66%). The combined data for the two periods indicates a final ratio of 72 fawns:100 does (72%).

The total deer classified were as follows:

116	does
84	fawns
16	bucks
216	Total

During the 1976 deer season, roadblocks and field interviews were conducted in the project area to monitor hunting pressure and success. The statistics obtained were as follows:

56 hunters
15 deer
26% success

These figures should be considered the minimum number, since some parties may have been missed.

c. Canada Geese

No Canada geese were observed.

d. Beaver

A total of 52 caches were counted, a decrease of five from 1975 counts.

e. Coyote and Bobcat

A single fresh bobcat track was observed along Evacuation Creek. Fresh coyote scats were located in most areas of the tracts and along all major roads. Subjective observation of coyote sign indicate a markedly higher population in the area from a year ago. Data from scent lines being run in the area may further substantiate this.

3. TERRESTRIAL INVERTEBRATES

A unified species list of arthropods of the tracts and a surrounding one-mile zone is being prepared. Over 90% of the determinations will be to the generic level, and probably somewhat less than 50% will be to the specific level. Several families are still with specialists, and many additional species have been acquired in families already determined. All of the material not completely determined will be sorted into presumed species, which will be listed numerically under their high taxonomic categories, such as sp. no. 1, 2, 3, etc.

The validation collection of over 10,000 specimens is being improved for useful reference. It will be housed at the Utah State University biology department. An additional validation collection of duplicate material will be kept at the Vernal State Museum for easier use by future investigators at the oil shale tracts or other potential developments in the area. This material will eventually be part of a more general Uinta Basin Collection.

4. AQUATIC BIOLOGY

Samples have been identified and enumerated, but the data have not been fully analyzed. The results will be discussed in the FEBR.

5. MICROBIOLOGY

The data concerning microbial numbers and activity indicate that productivity will increase next autumn, probably as a result of organic-matter inputs from litter. In general, the activities observed during fall 1976 were somewhat lower than those observed during fall 1975, reflecting the limited moisture in fall 1976.

a. Microbial Numbers

Microbial numbers (especially fungi), as determined by plate-count methods, increased at the surface of all sites in the fall. This general increase can probably be attributed to organic-matter inputs from litter accumulation. The fluctuation in numbers observed in the lower layers was due in part to differences in water content and aeration throughout the profile. Overall, the values noted were somewhat lower than those of last year, probably because of the lack of moisture during fall 1976. Microbial data are listed on tables IV-5 through IV-8.

b. Dehydrogenase Activity

Dehydrogenase levels increased significantly in August at the surfaces of all sites, reinforcing similar observations of the previous year, when activity increased with larger water potentials. This relationship will be statistically analyzed, and the results will be reported in the FEBR. Dehydrogenase data for August 13 are listed on Table IV-9.

c. Water Potential

Water-potential data from the September sample indicate a drying trend in the lower depths and increased moisture retention at the surface. Increased organic matter and cooler temperatures are factors involved. The exception was Site 39, where water potentials decreased throughout the profile from the seasonal highs noted in August. A large decrease in water potential was observed in the interspace soil at Site 50J from August to September. Water-potential data for September samples are listed on Table IV-10.

d. Organic Carbon and Total Nitrogen Content

Increases in the relative content of organic carbon were observed in the interspace soils of both the juniper site (50JI) and Site 58. Decreases were noted at all other sites from June through August. Supporting respiration data from August samples (reported in Quarterly Report 8) reflect the small overall decline in the relative content of organic carbon observed.

TABLE IV-5

AEROBIC BACTERIA
(Number per Gram of Soil)

SAMPLE	SEPT. 23, 1976	NOV.12, 1976
39-1	1.57×10^6	2.60×10^6
39-2	7.40×10^5	9.60×10^5
39-3	3.00×10^6	9.50×10^5
50JC-1	2.30×10^6	2.30×10^6
50JI-1	7.50×10^6	2.30×10^6
55R-1	1.12×10^6	7.9×10^5
55R-2	6.70×10^5	5.3×10^5
55R-3	6.80×10^5	2.8×10^5
58C-1	2.13×10^6	1.30×10^6
58C-2	7.60×10^5	1.14×10^6
58C-3	4.90×10^5	1.13×10^6
58I-1	2.96×10^6	9.70×10^5
58I-2	7.10×10^5	7.20×10^5
58I-3	6.80×10^5	6.40×10^5
50J-L	4.00×10^6	8.40×10^6
58-L	--	--

TABLE IV-6

ANAEROBIC BACTERIA
(Number Per Gram of Soil)

SAMPLE	SEPT. 23, 1976	NOV.12, 1976
39-1	8.00×10^{3}	1.86×10^{4}
39-2	1.86×10^{3}	2.76×10^{4}
39-3	3.00×10^{4}	1.90×10^{4}
50JC-1	7.00×10^{3}	4.30×10^{3}
50JI-1	2.90×10^{4}	5.60×10^{3}
55R-1	1.36×10^{4}	5.60×10^{3}
55R-2	9.00×10^{3}	3.00×10^{3}
55R-3	9.60×10^{3}	7.00×10^{2}
58C-1	2.60×10^{4}	2.56×10^{4}
58C-2	1.90×10^{4}	2.30×10^{4}
58C-3	9.30×10^{3}	2.30×10^{4}
58I-1	6.30×10^{3}	2.40×10^{4}
58I-2	9.00×10^{3}	1.60×10^{4}
58I-3	5.60×10^{3}	1.04×10^{4}
50J-L	3.00×10^{3}	3.00×10^{2}
58-L	--	--

TABLE IV-7

STREPTOMYCETES
(Number per Gram of Soil)

SAMPLE	SEPT. 23, 1976	NOV. 12, 1976
39-1	6.80×10^5	1.90×10^6
39-2	2.60×10^5	5.40×10^5
39-3	2.30×10^6	5.20×10^5
50JC-1	1.30×10^6	1.30×10^6
50JI-1	2.50×10^6	1.60×10^6
55R-1	5.40×10^5	1.90×10^5
55R-2	2.80×10^5	2.10×10^5
55R-3	5.10×10^5	1.30×10^5
58C-1	1.60×10^6	5.30×10^5
58C-2	2.50×10^5	5.46×10^5
58C-3	9.30×10^4	3.90×10^5
58I-1	1.16×10^6	6.20×10^5
58I-2	3.60×10^5	2.60×10^5
58I-3	4.20×10^5	2.16×10^5
50J-L	7.00×10^5	3.30×10^5
58-L	--	--

TABLE IV-8

FUNGI
(Number per Gram of Soil)

SAMPLE	SEPT. 23, 1976	NOV. 12, 1976
39-1	1.26×10^4	3.70×10^4
39-2	6.00×10^3	1.80×10^4
39-3	3.76×10^5	1.76×10^4
50JC-1	4.60×10^4	4.70×10^4
50JI-1	1.90×10^4	7.30×10^3
55R-1	3.14×10^4	2.50×10^4
55R-2	2.40×10^4	1.06×10^4
55R-3	2.10×10^4	4.30×10^3
58C-1	4.76×10^4	2.30×10^4
58C-2	4.10×10^4	3.10×10^4
58C-3	4.70×10^4	2.70×10^4
58I-1	7.30×10^3	2.80×10^4
58I-2	6.30×10^3	8.00×10^3
58I-3	7.60×10^3	5.30×10^3
50J-L	1.60×10^5	5.60×10^4
58-L	--	--

TABLE IV-9

DEHYDROGENASE
FORMAZAN MG/ML

SAMPLE	AUG. 13, 1976
39-1	0.207
39-2	0.014
39-3	0.031
50JC-1	0.469
50JI-1	0.208
55R-1	0.663
55R-2	0.168
55R-3	0.016
58C-1	0.168
58C-2	0.155
58C-3	0.031
58I-1	0.058
58I-2	0.045
58I-3	0.020
50J-L	0.432

TABLE IV-10

WATER POTENTIAL
-BARS

SAMPLE	SEPT.23, 1976
39-1	78.9
39-2	52.1
39-3	29.0
50JC-1	63.8
50JI-1	8.5
55R-1	100.0
55R-2	106.8
55R-3	60.3
58C-1	57.5
58C-2	111.5
58C-3	119.2
58I-1	68.5
58I-2	153.4
58I-3	101.4
50J-L	87.4
58-L	--

Total nitrogen values remained relatively stable at all sites except Site 39 at a depth of 5 cm to 20 cm, where the values increased 0.15% from the June 30 value. The generally constant values are consistent with those found throughout 1975. The values computed from August analyses are listed on Table IV-11.

e. Nitrate Content

Nitrate (No_3^-) concentrations were higher at sites 39 and 50J but decreased at all other sites. The surface soil under the canopy at Site 58 continued to exhibit the highest values overall (6.7 µg/g NO_3^--N) for the mid-August collection date. The lowest values (0.2 µg/g NO_3^--N) were observed in the lower depths at the riparian (55R) site. Data for nitrate contents are listed on Table IV-12.

6. TRACE ELEMENTS

No trace-element studies were conducted on vegetation or wildlife, since low levels of trace elements were found in the soils tested (Quarterly Report 8) in accordance with AOSO approval of the revised biological resources program.

C. WORK SCHEDULED

Data compilation and analysis are in progress for all programs for inclusion within the FEBR. Final field activities were conducted through January 15, 1977, the end of the two-year environmental baseline program. Activities for suspension monitoring to be conducted after January 15 are covered in the Work Plan--Lease Suspension Period Environmental Programs, WRSP.

TABLE IV-11

ORGANIC CARBON AND TOTAL NITROGEN CONTENT

SAMPLE	AUG. 13, 1976		
	% Org. C	% Total N	C/N
39-1	0.33	0.03	11.0
39-2	0.38	0.20	1.9
39-3	0.26	0.03	8.7
50JC-1	1.56	0.14	11.1
50JI-1	1.31	0.14	9.4
55R-1	0.75	0.06	12.5
55R-2	0.63	0.05	12.6
55R-3	0.58	0.06	9.7
58C-1	0.66	0.07	9.4
58C-2	0.43	0.04	10.8
58C-3	0.35	0.04	8.8
58I-1	0.74	0.04	18.5
58I-2	0.44	0.05	8.8
58I-3	0.38	0.03	12.6
50J-L	16.70	0.15	111.3
58-L	--	--	--

TABLE IV-12

NITRATE CONTENT

NO_3^--N

Scientific Type μg/g

SAMPLE	AUG.13, 1976
39-1	2.1
39-2	1.4
39-3	1.0
50JC-1	0.4
50JI-1	1.7
55R-1	0.3
55R-2	0.2
55R-3	0.2
58C-1	6.7
58C-2	1.9
58C-3	1.1
58I-1	2.1
58I-2	0.5
58I-3	0.4
50J-L	0.3
58-L	---